

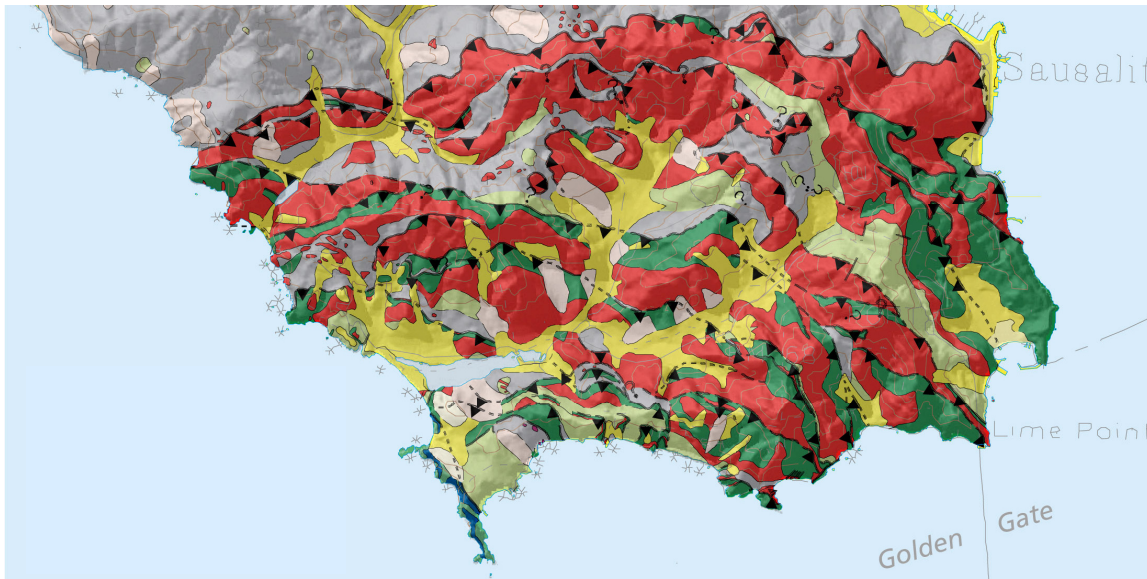
National Park Service

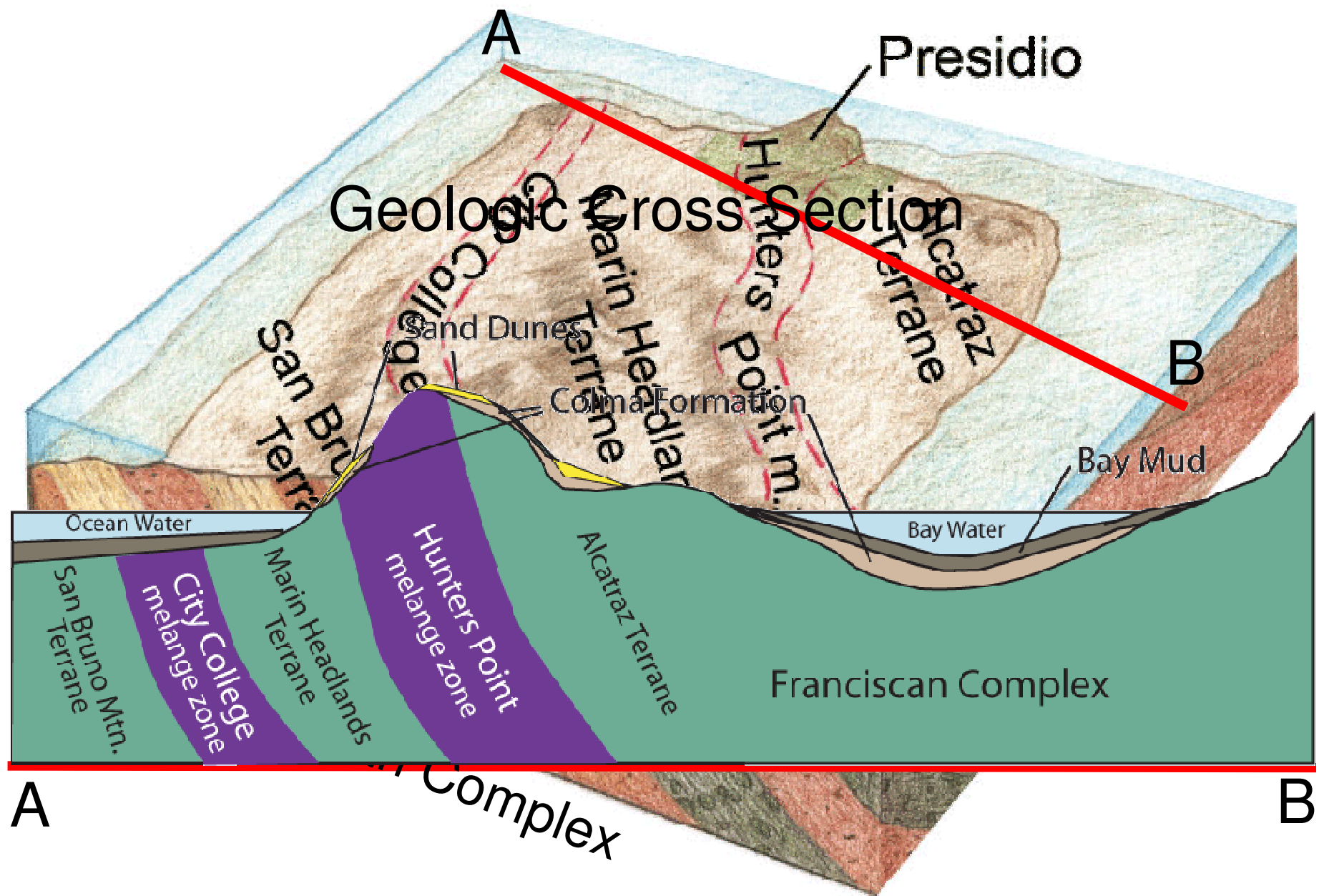
Golden Gate National Recreation Area

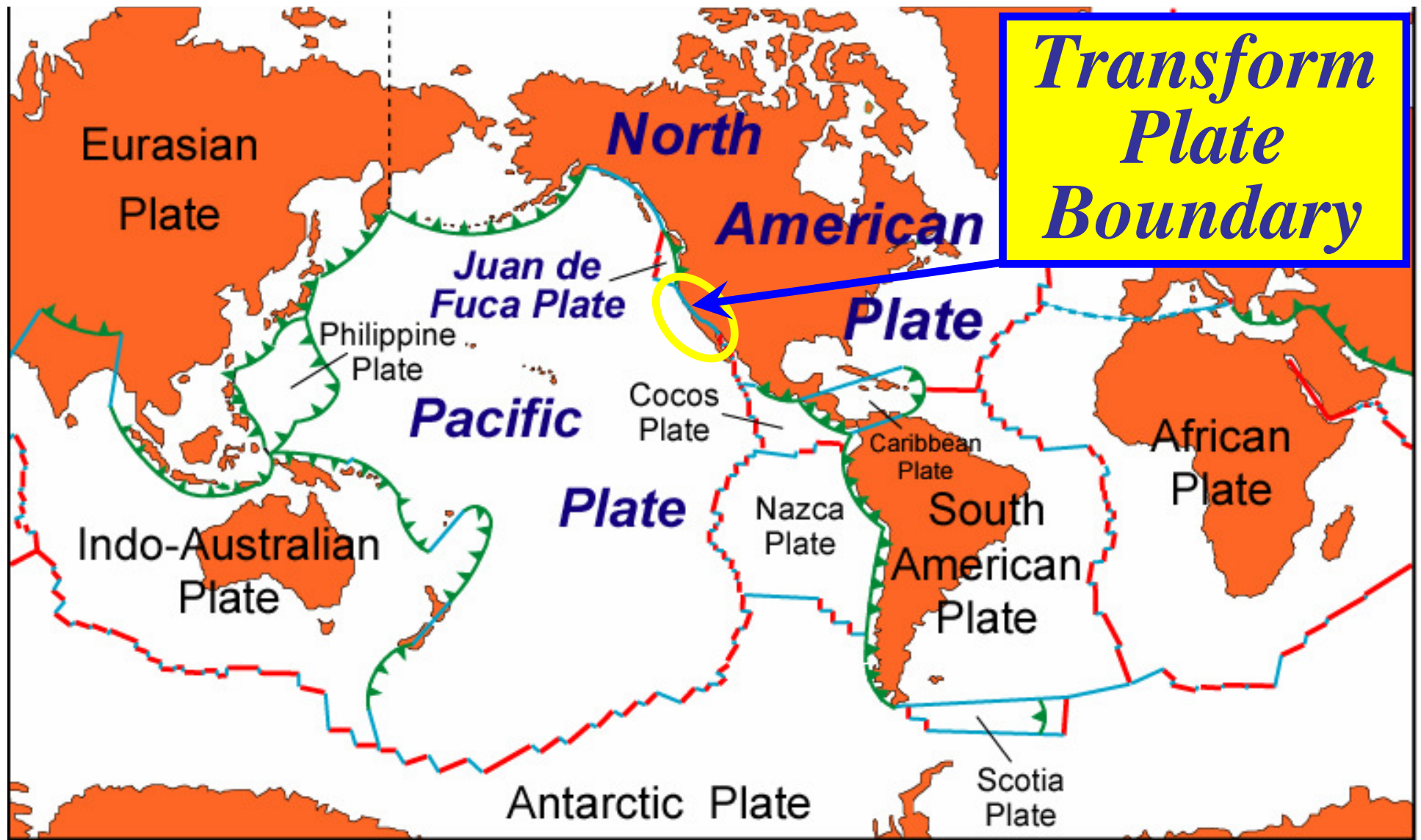


EXPERIENCE
YOUR
AMERICA

Geology of the Golden Gate Headlands







Divergent

Convergent

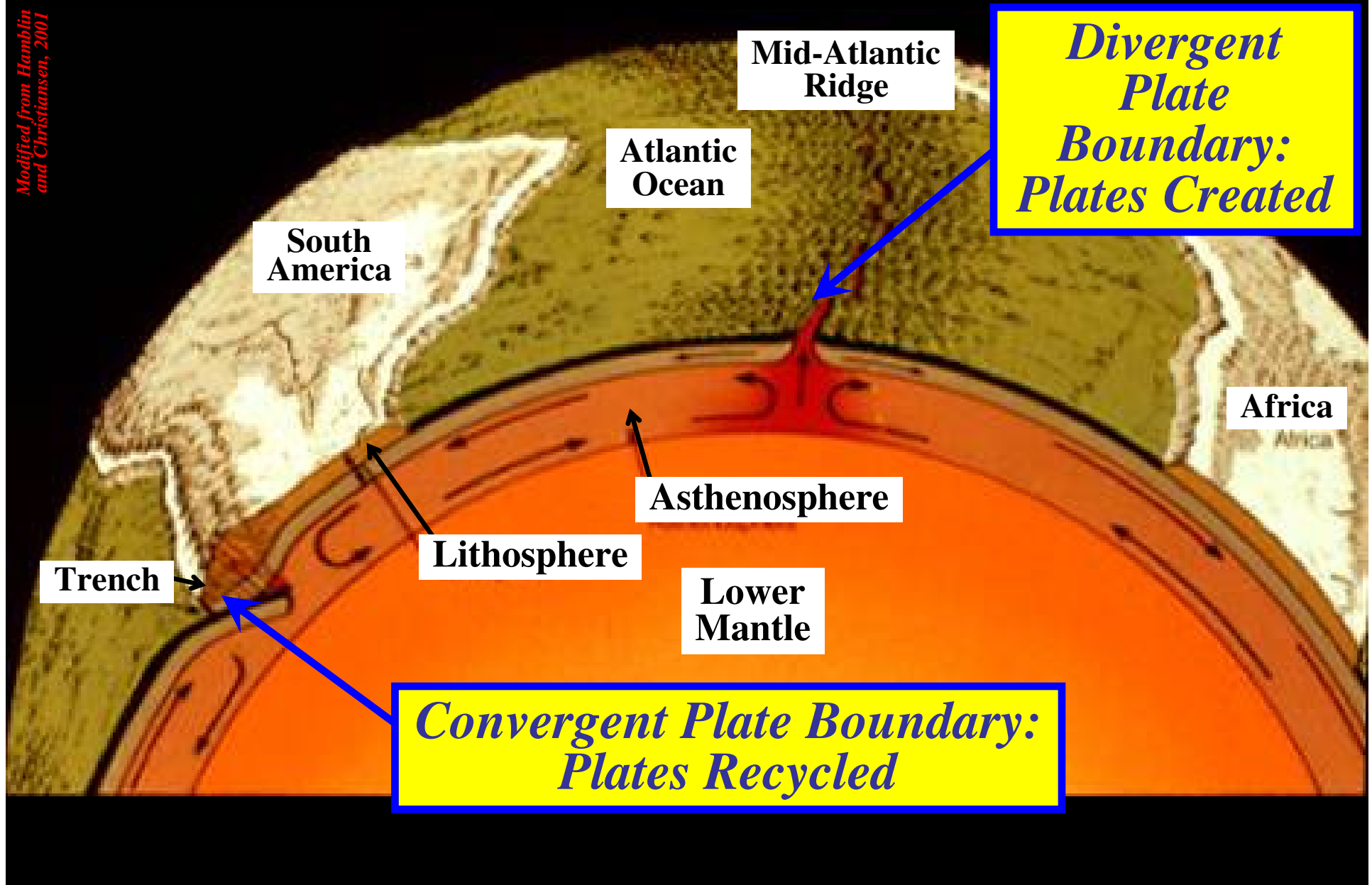
"Teeth" on
Overriding Plate

Transform

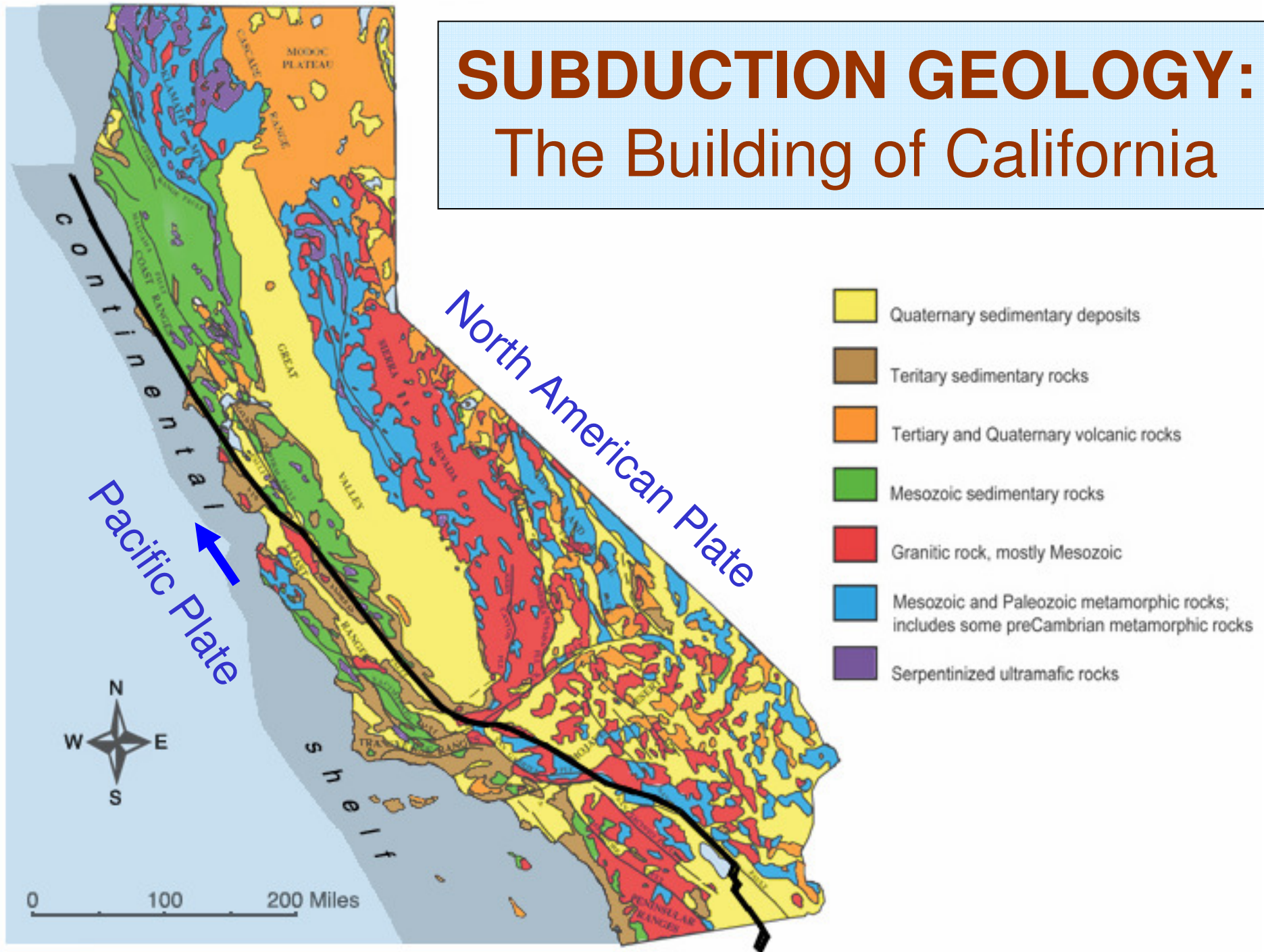
Plate Boundaries

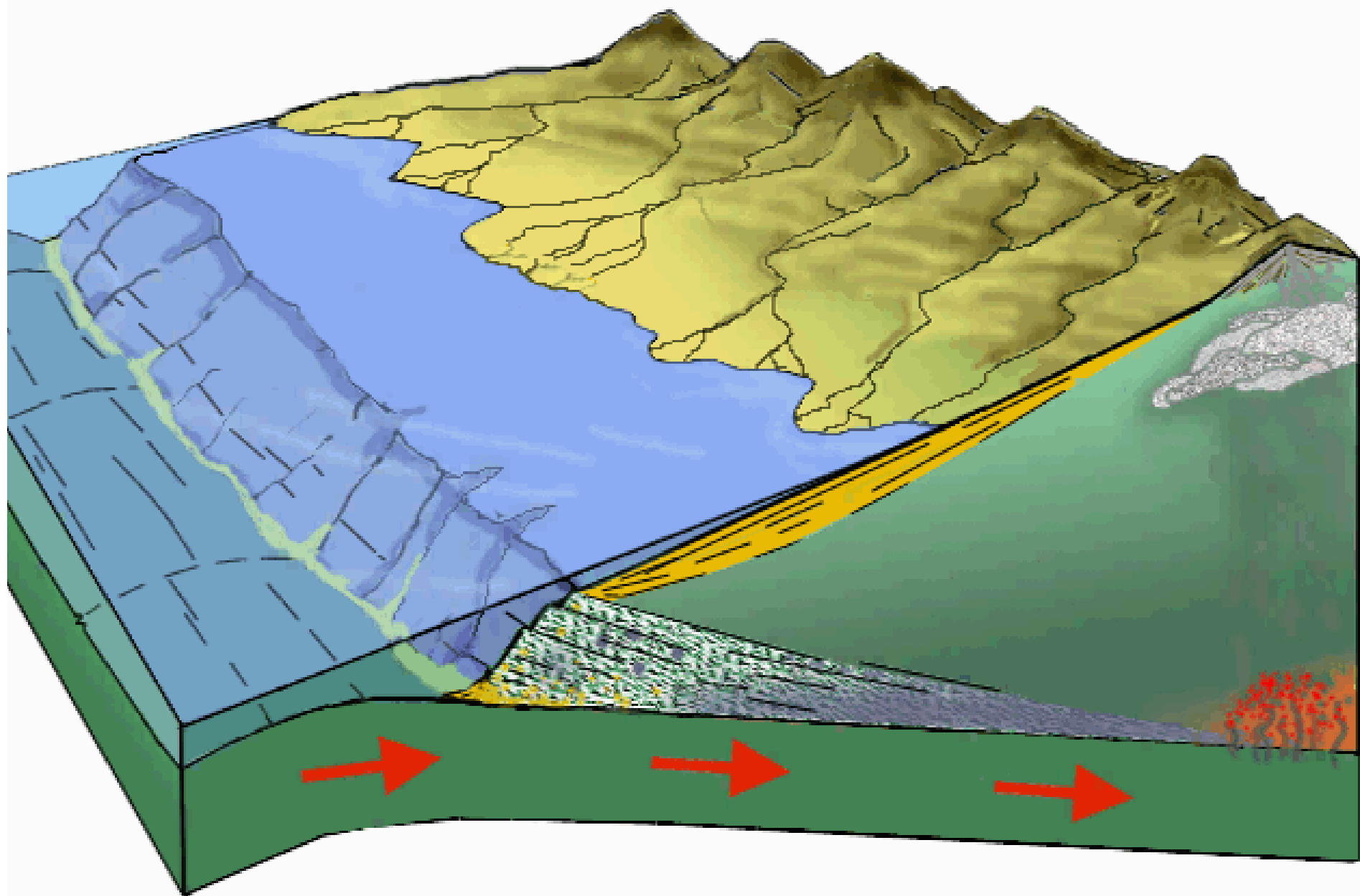
Earth is a Giant Recycling Machine!

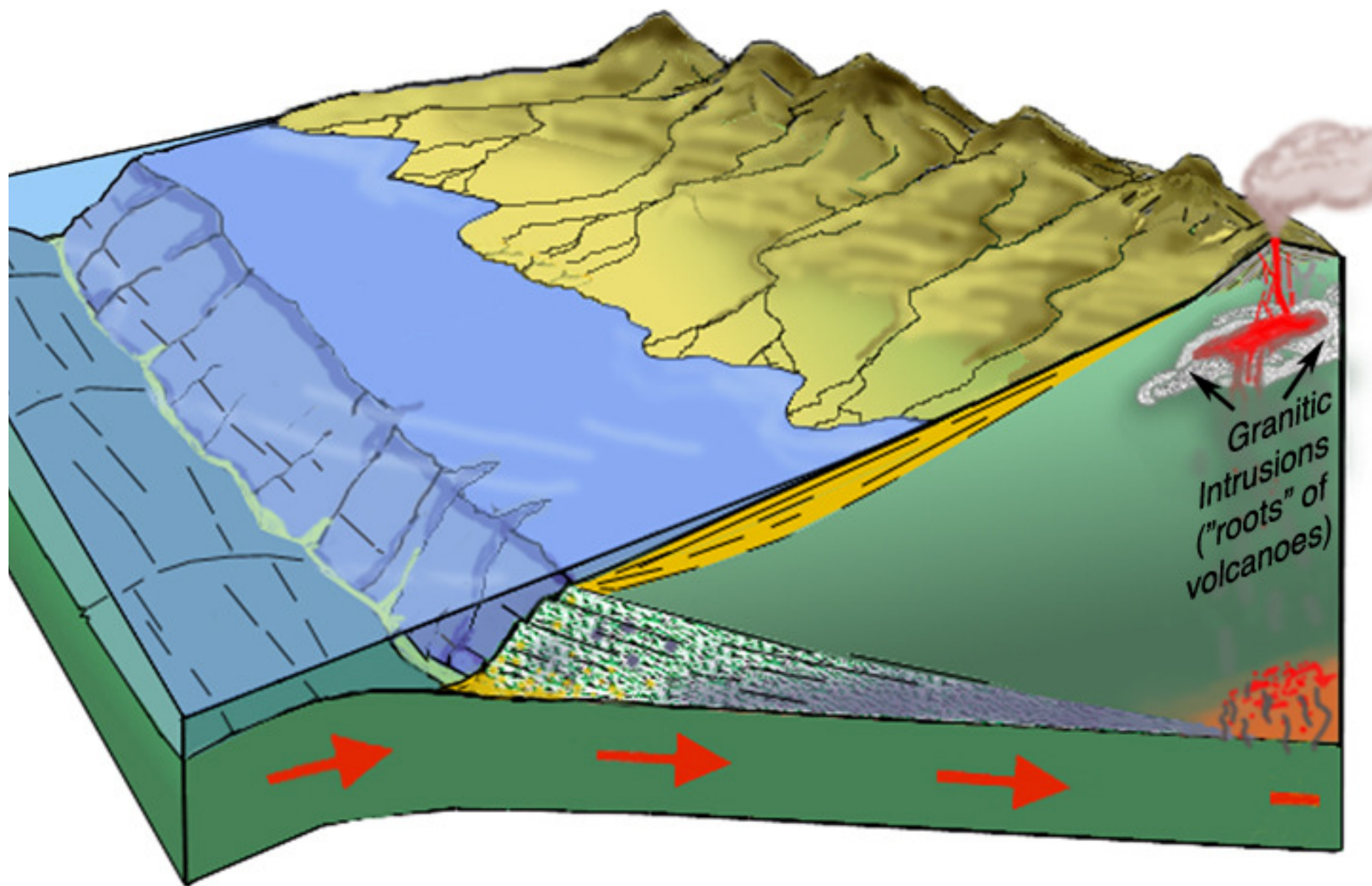
Modified from Hamblin
and Christiansen, 2001

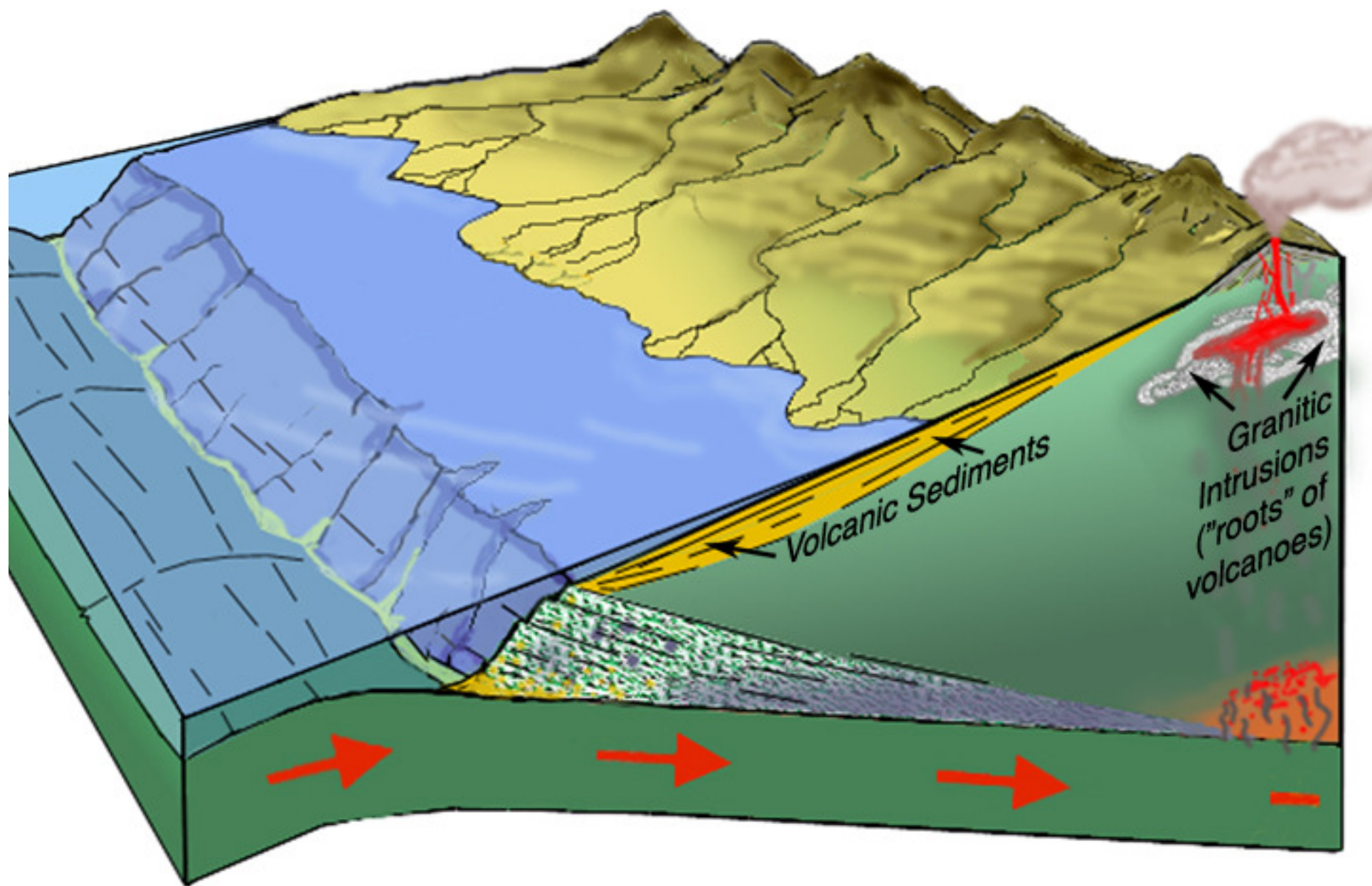


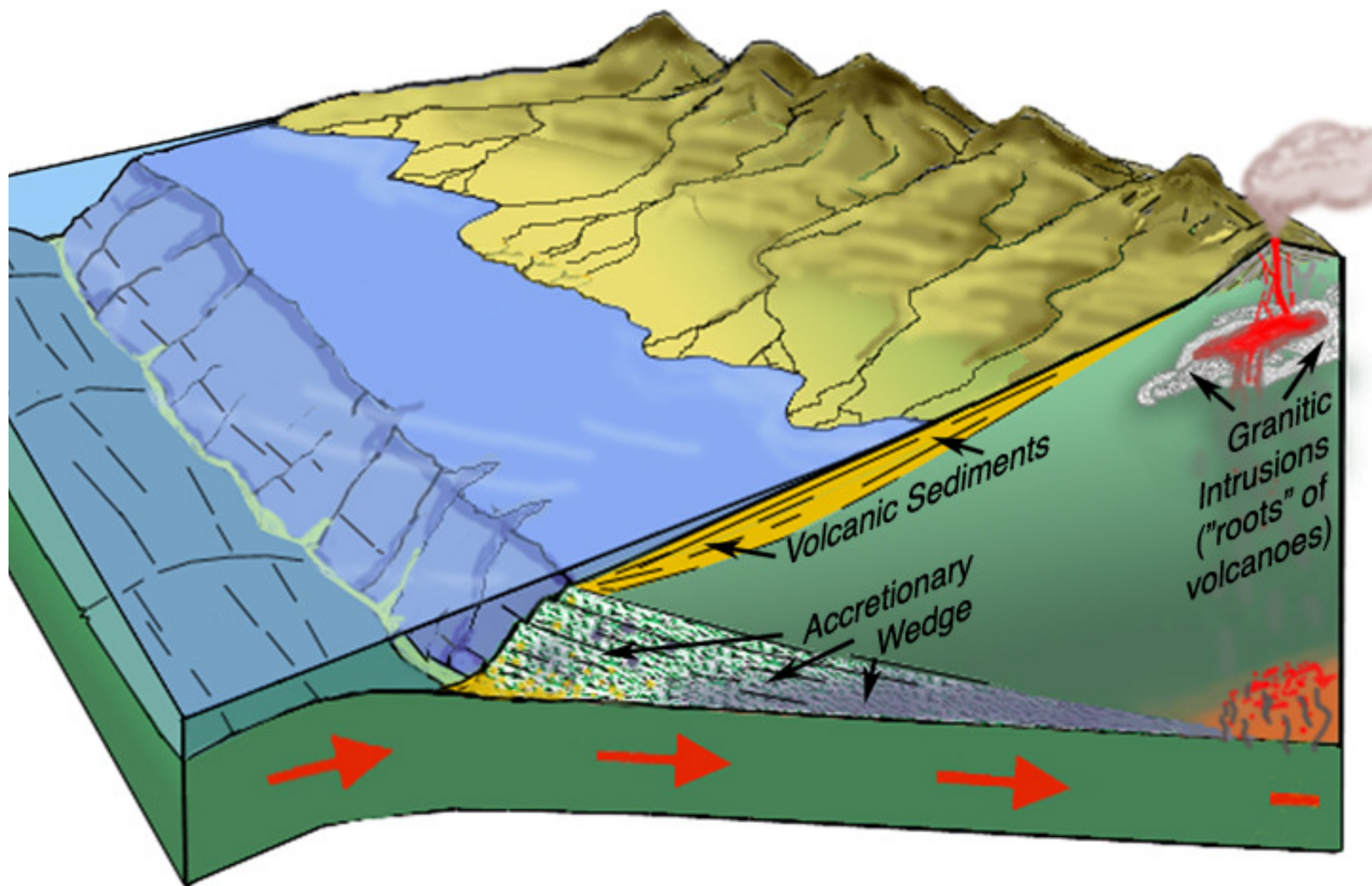
SUBDUCTION GEOLOGY: The Building of California

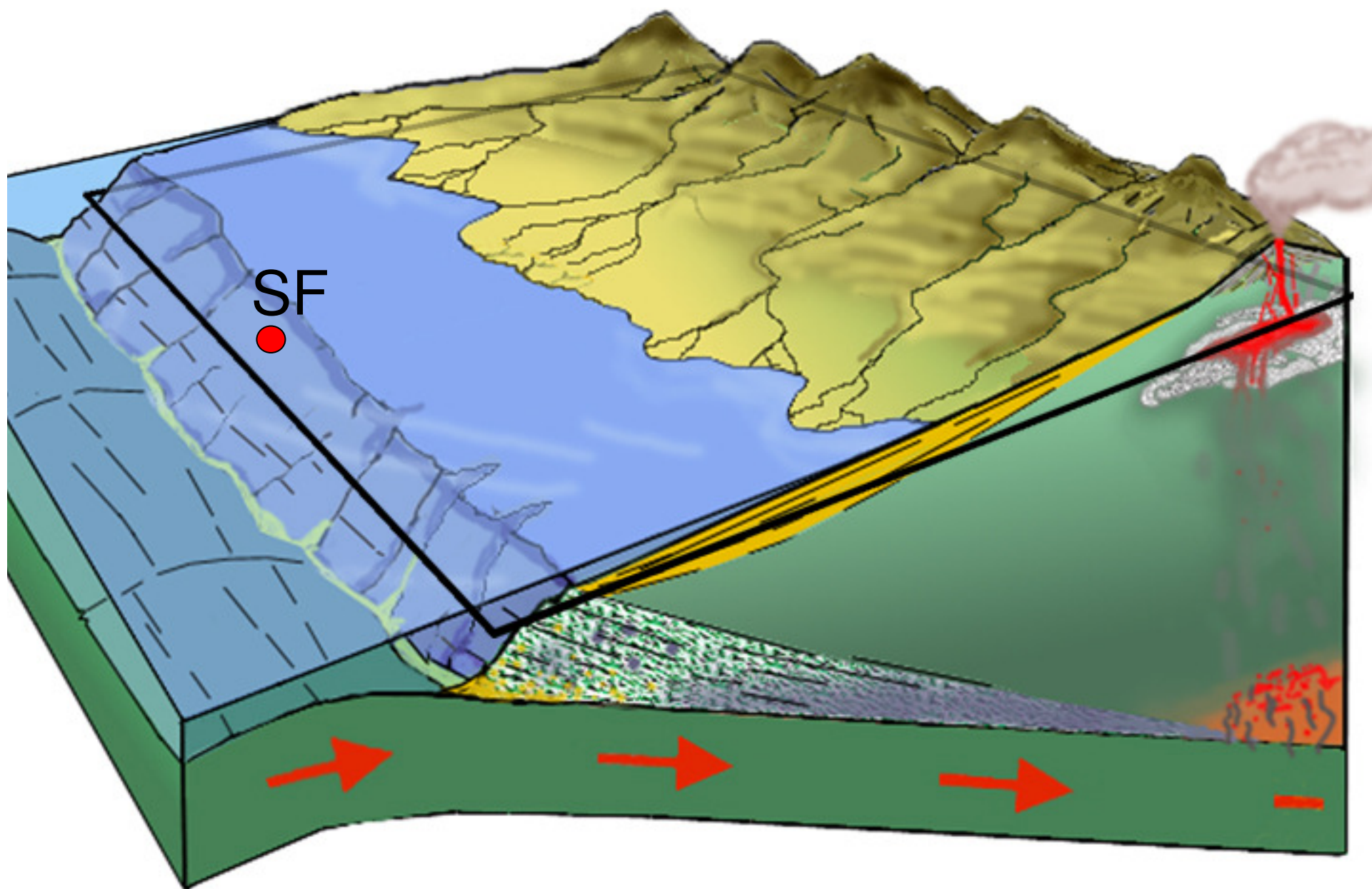


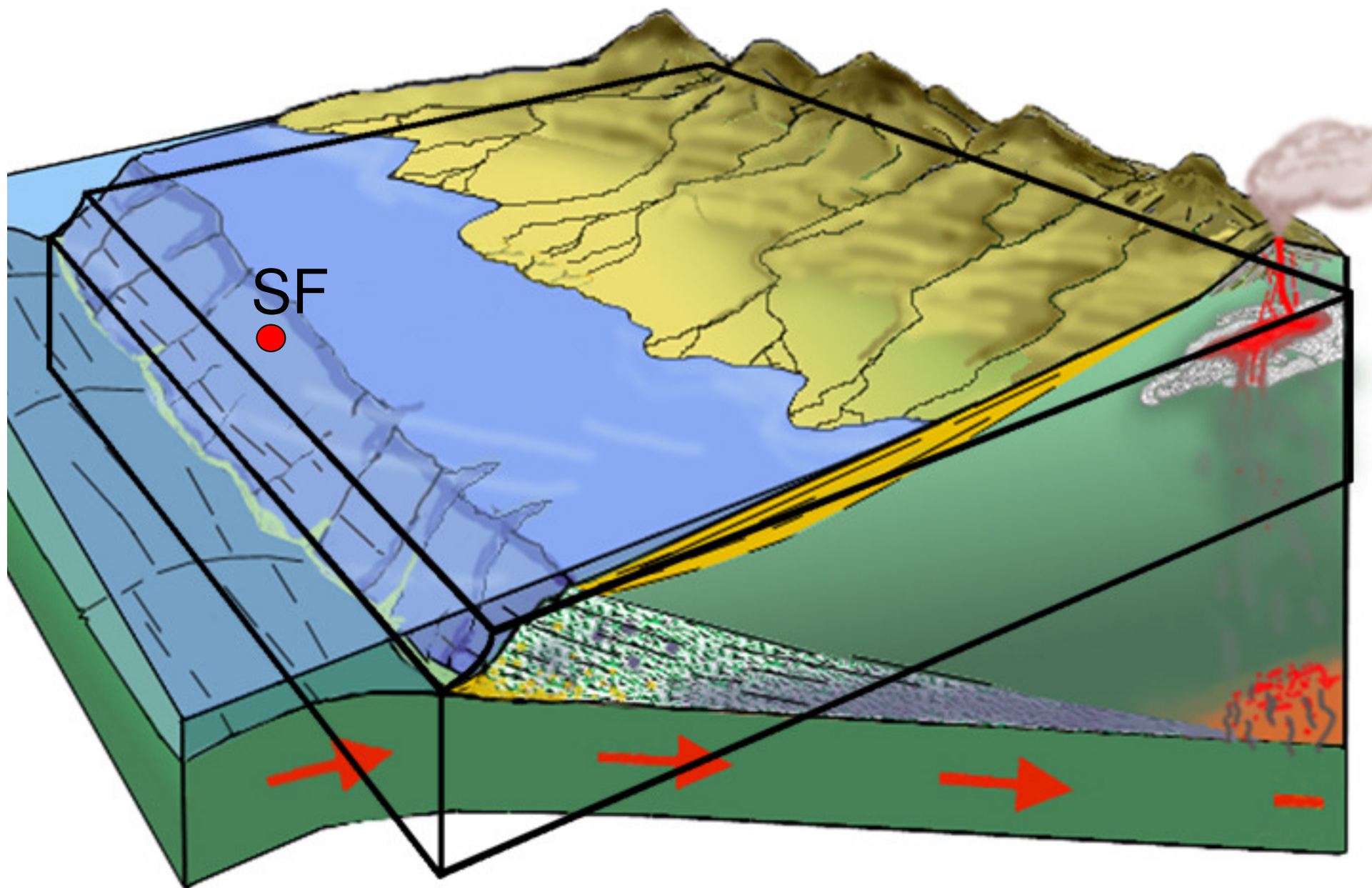


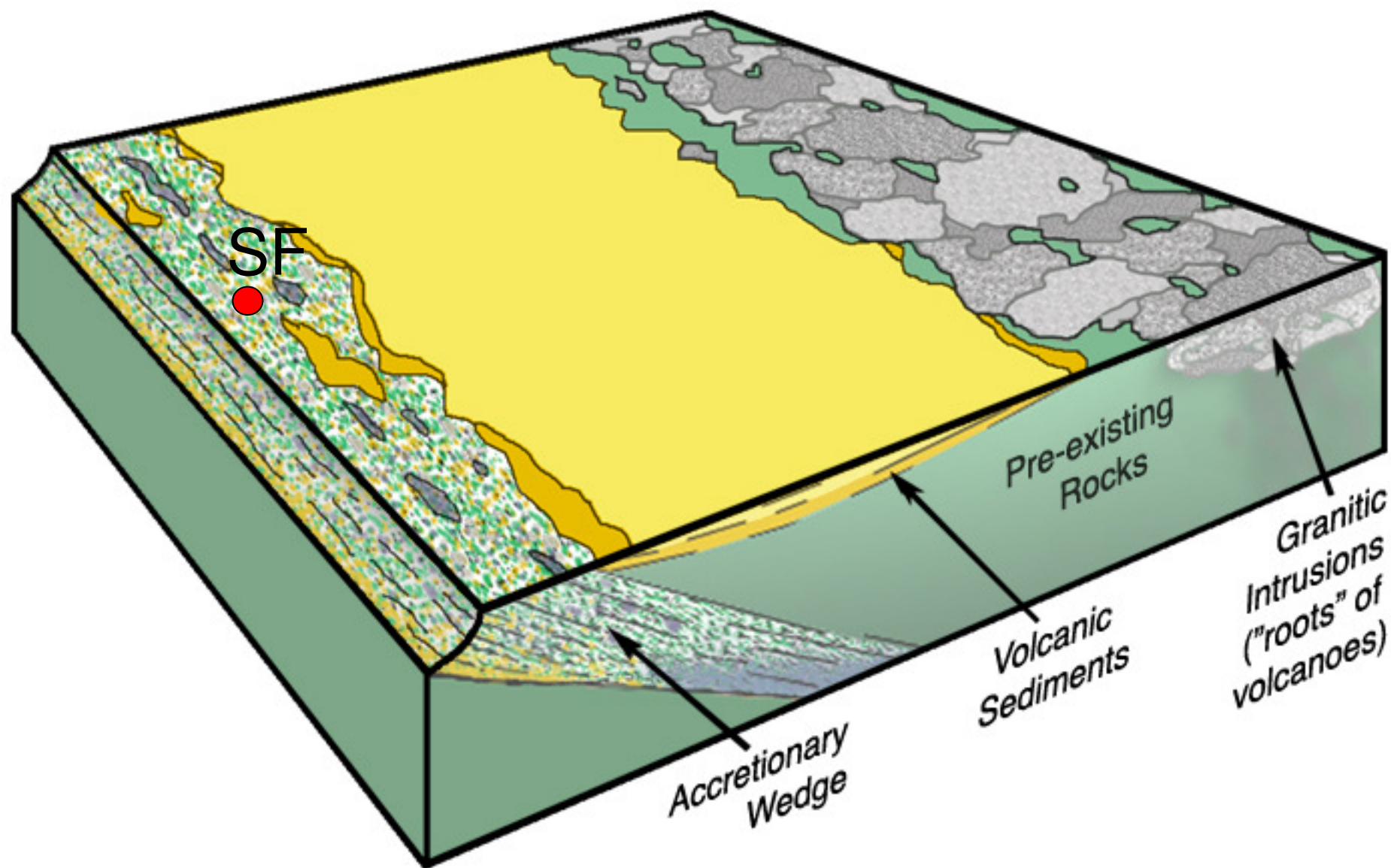


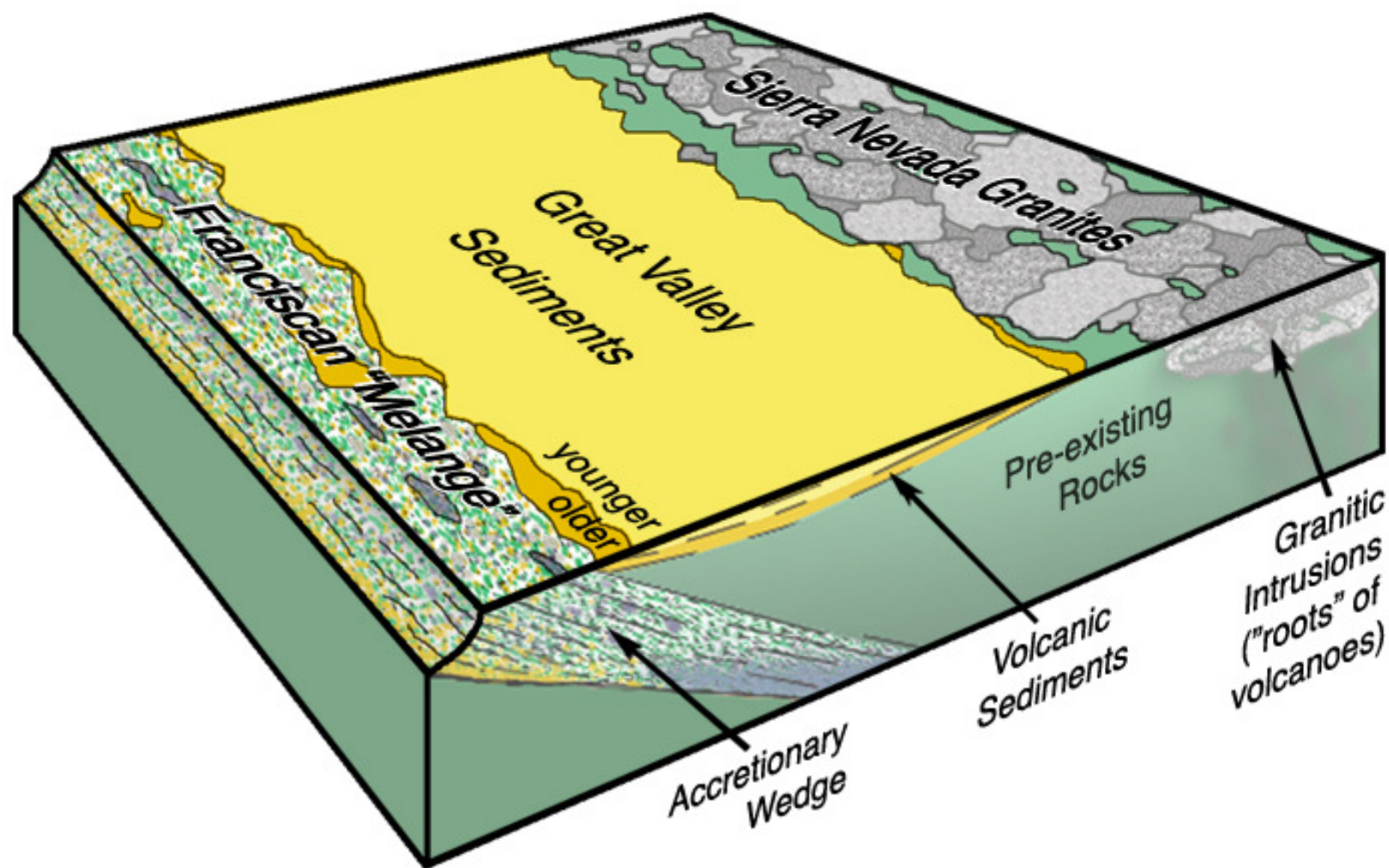


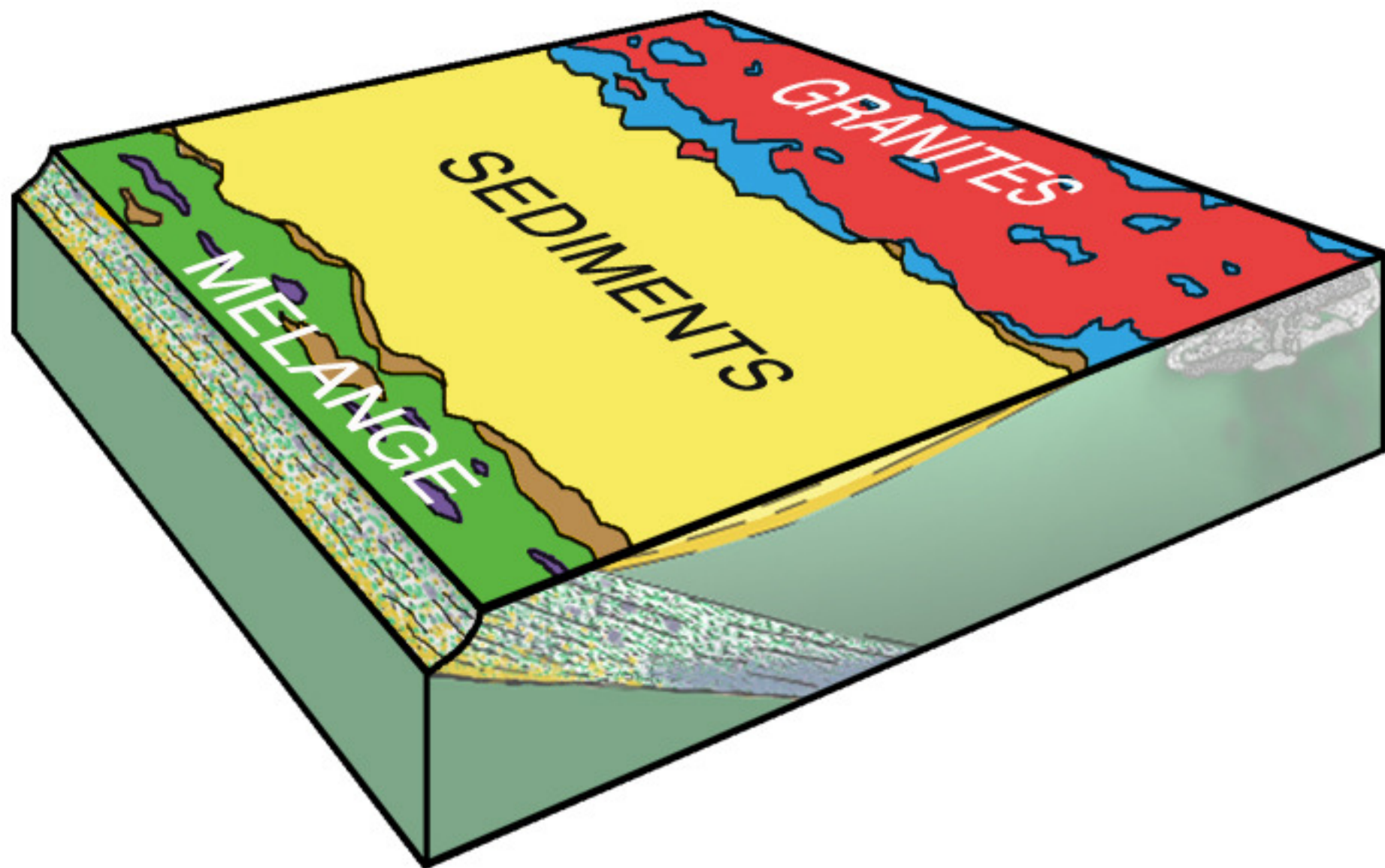


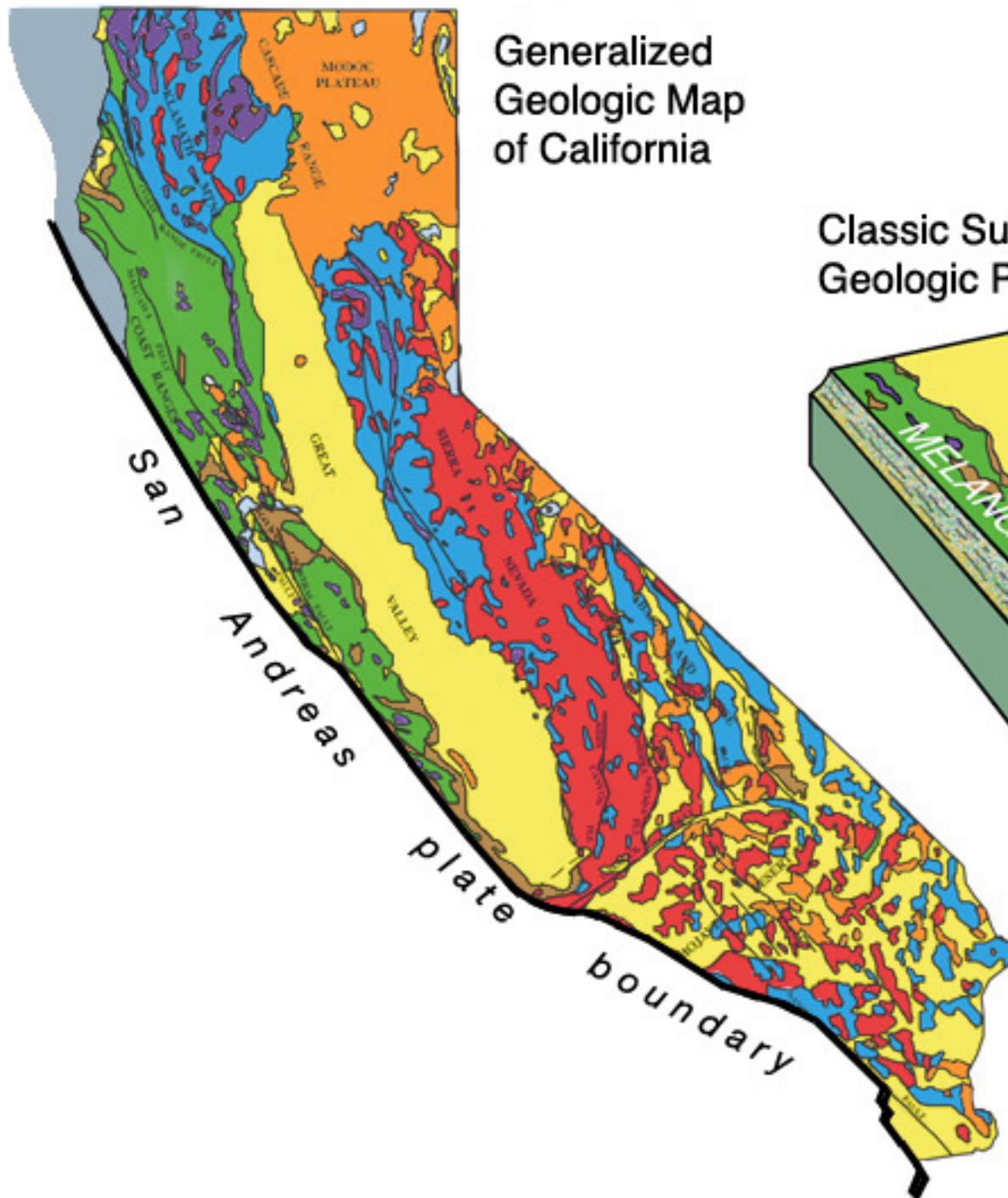




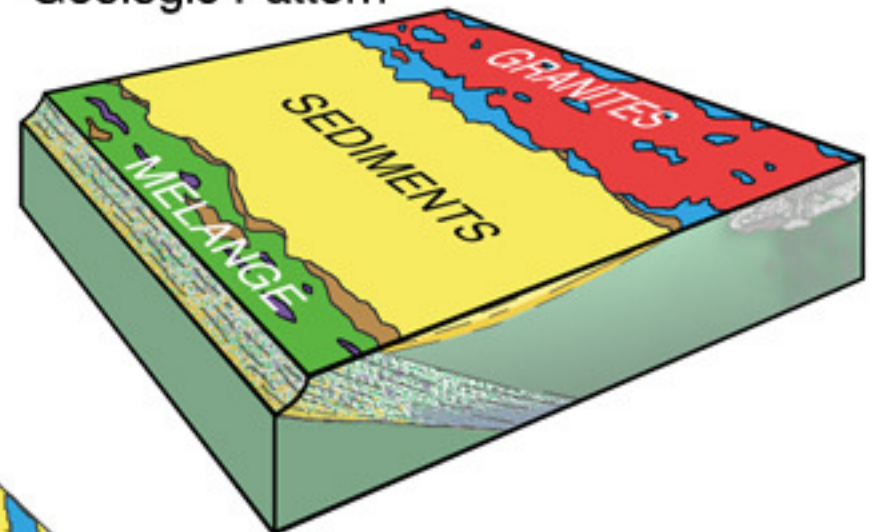




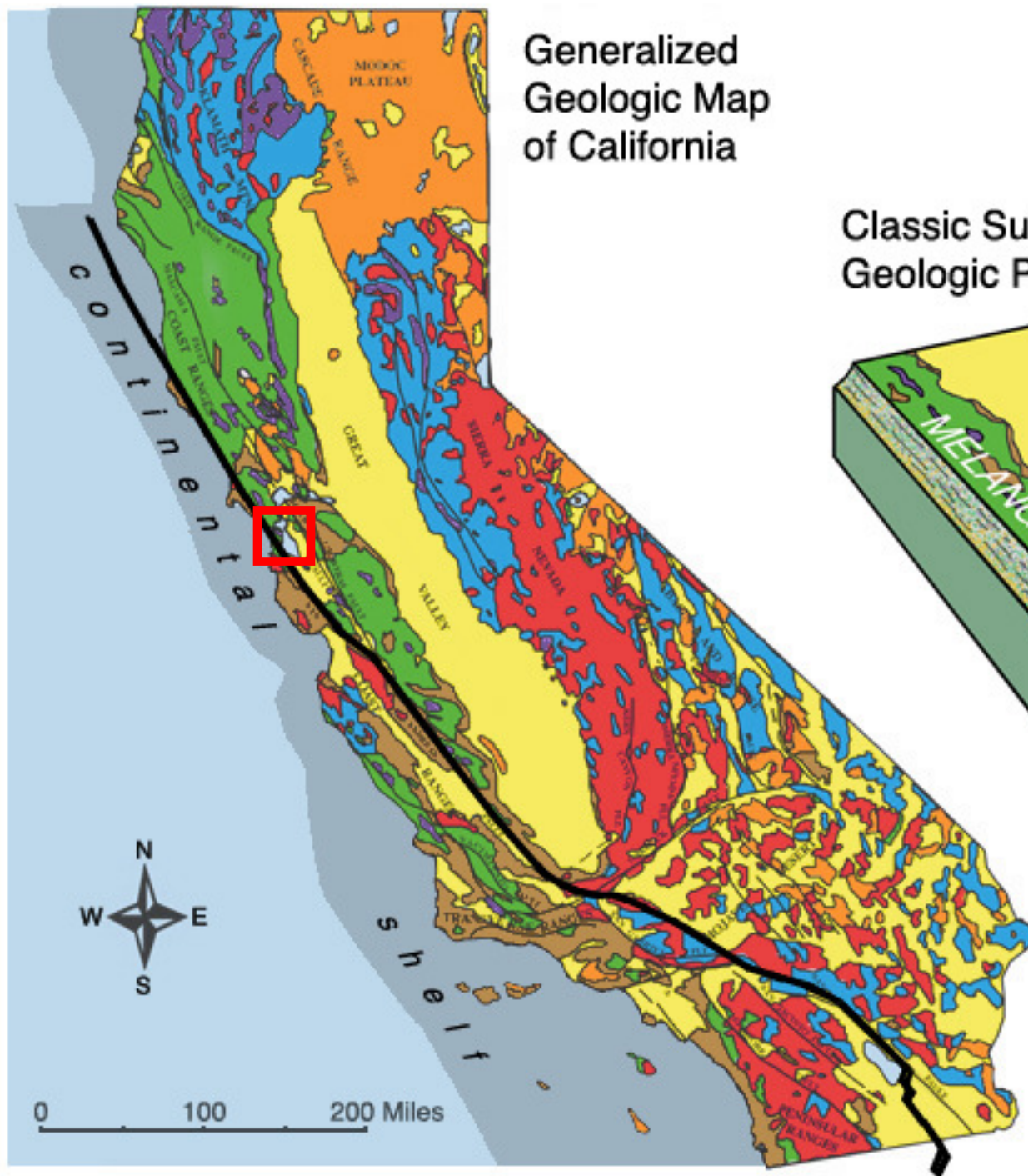




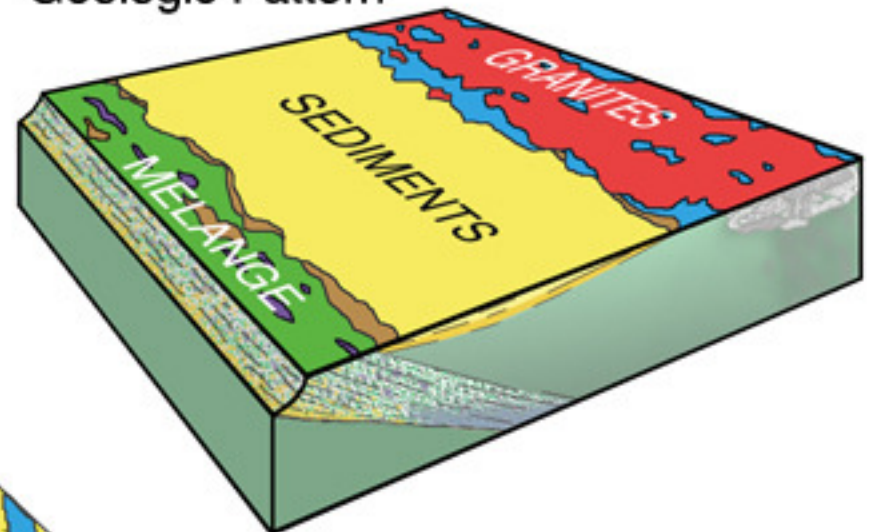
Classic Subduction-generated
Geologic Pattern

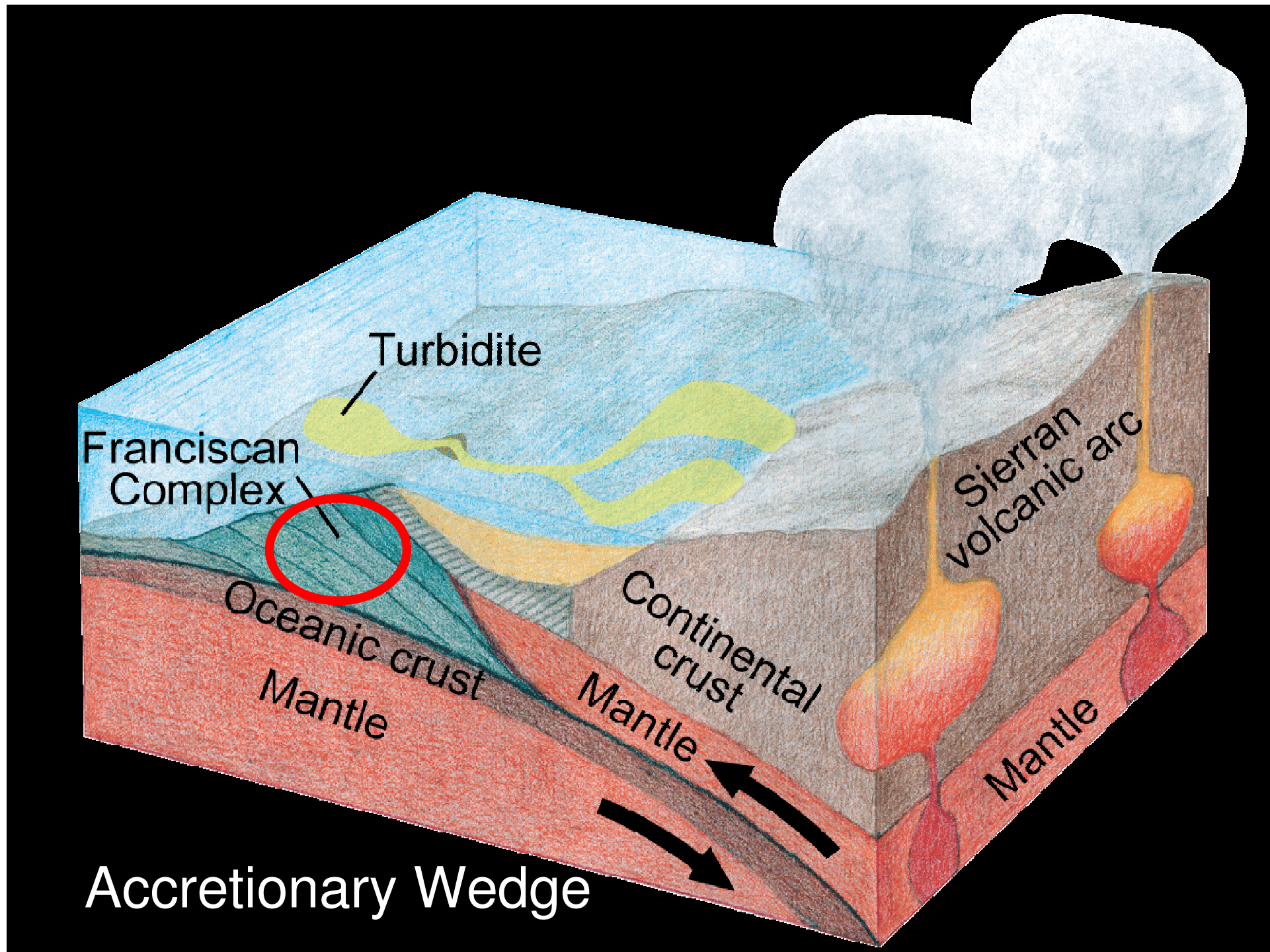


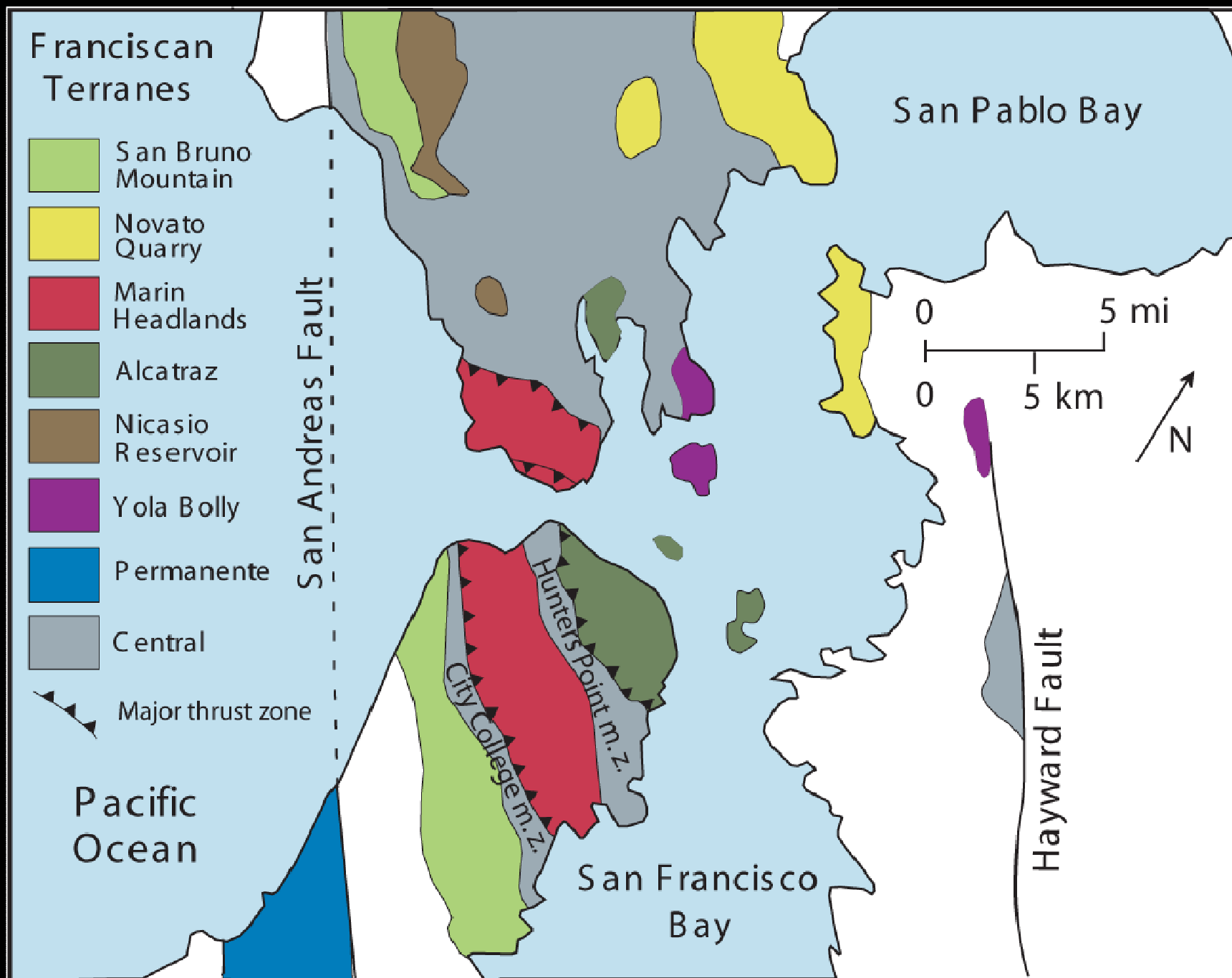
Generalized
Geologic Map
of California



Classic Subduction-generated
Geologic Pattern









Melange, North Baker Beach



Graywacke Sandstone
Submarine landslide



Ribbon Chert
Deep sea mud



Pillow Basalt
Submarine volcanic flow

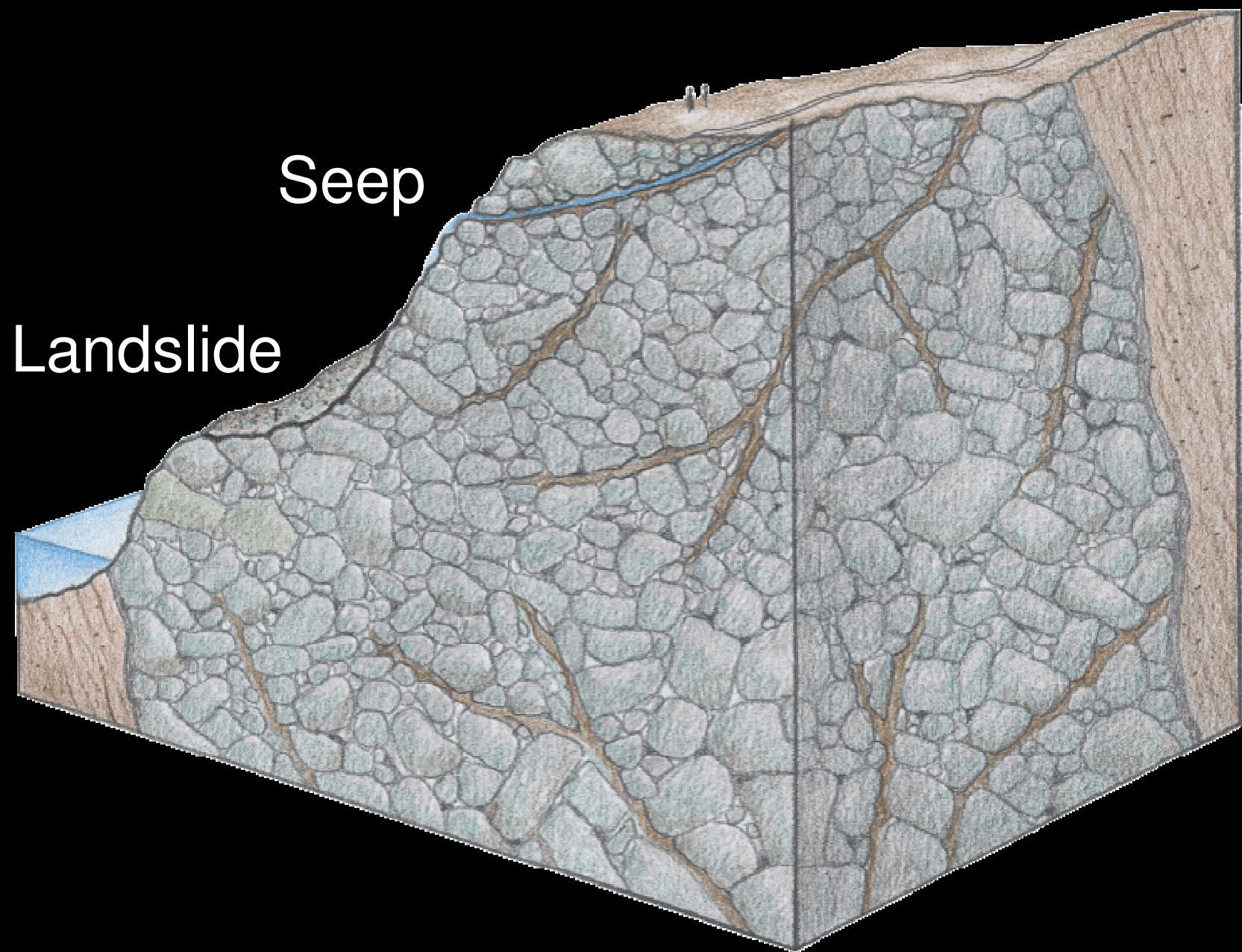


Serpentinite
Altered mantle rock

Serpentine



- Typically bluish green
- Often has slick or waxy appearing surface
- Bronze-color crystals sometimes visible
- Fibrous veins of asbestos common
- Typically forms large rounded blocks on outcrop



Seep

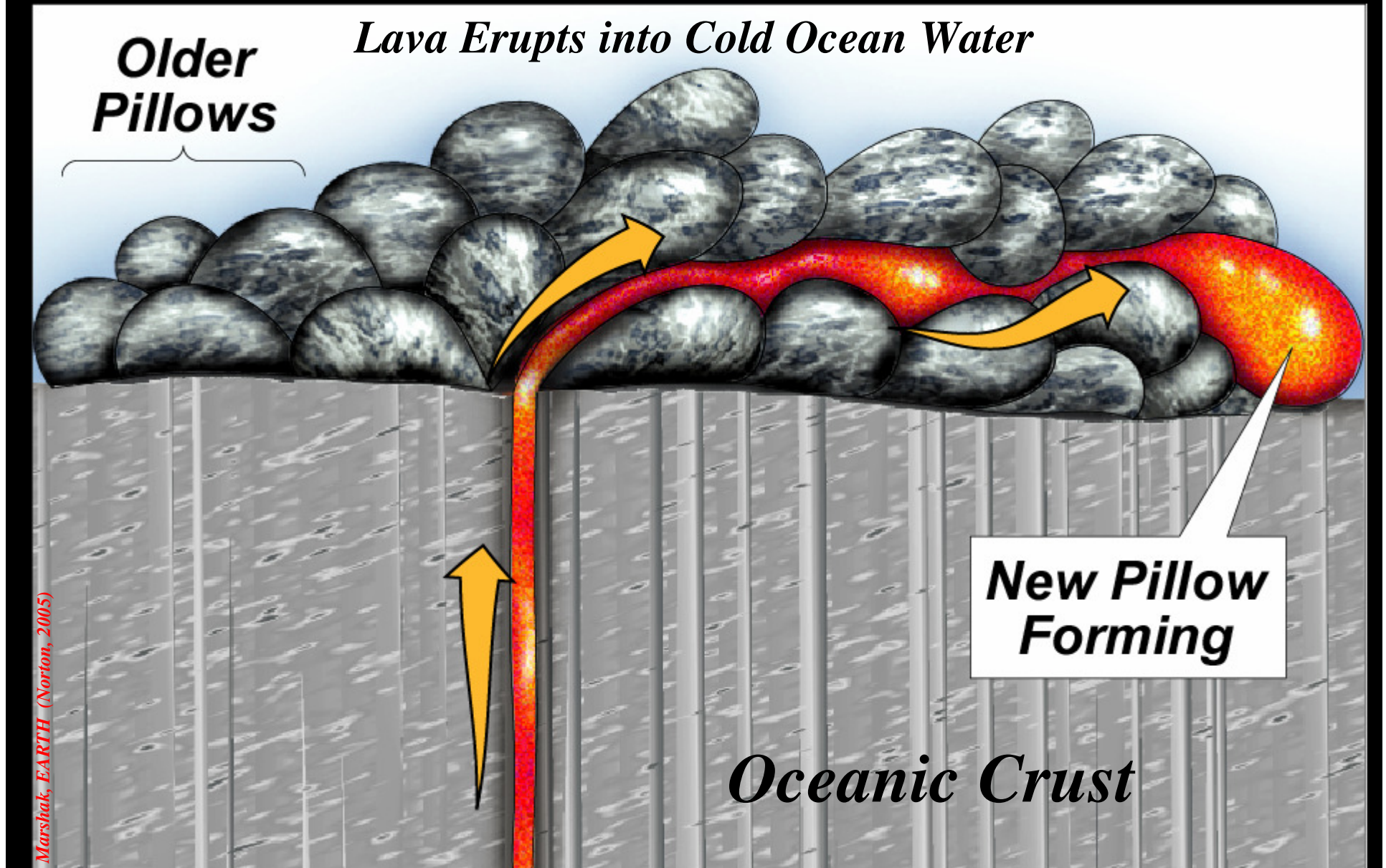
Landslide

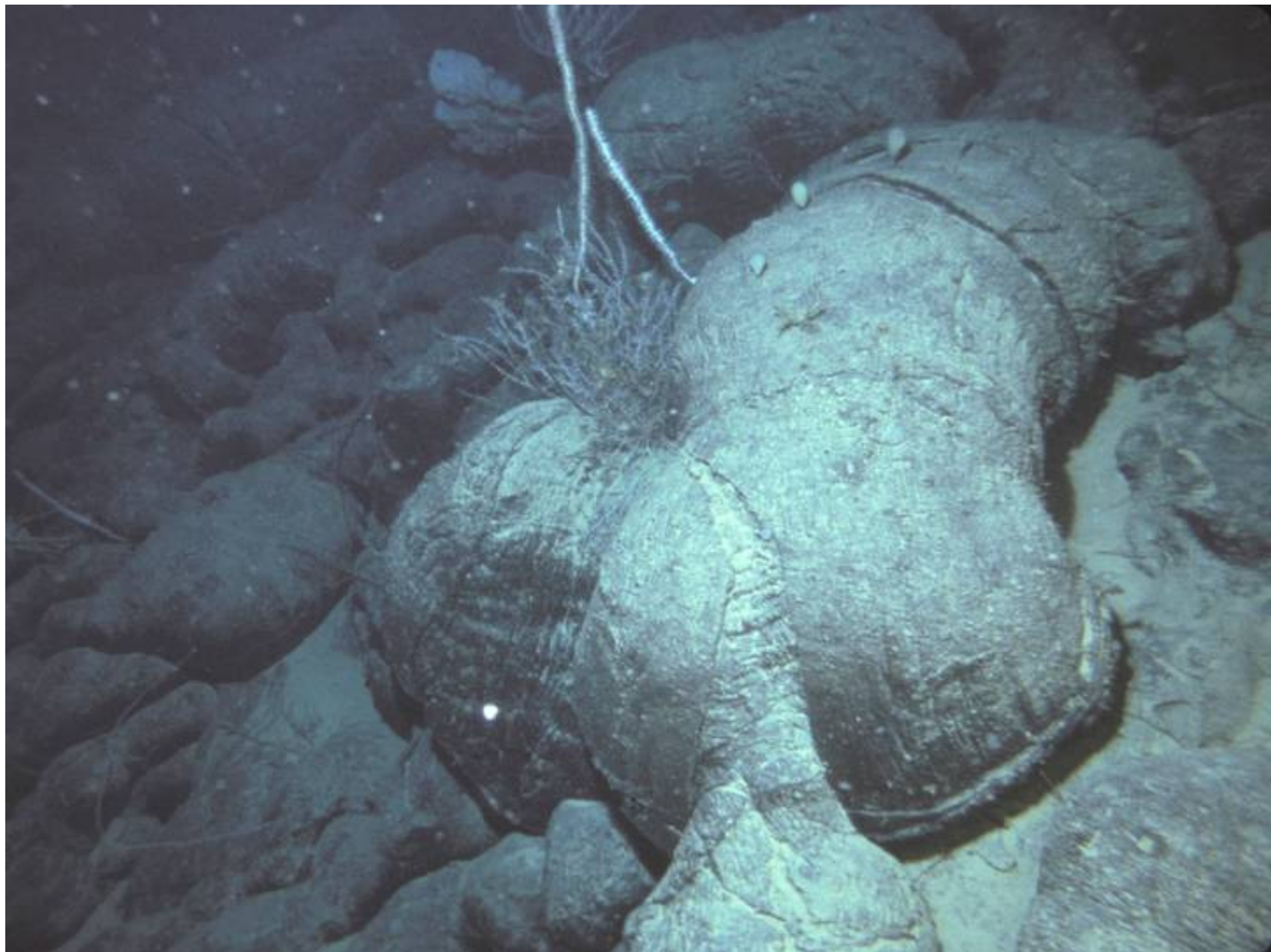
Basalt or Greenstone



- Dark greenish gray to black
- Tiny to no visible crystalline matrix or grains
- May have small holes (vesicles) sometimes infilled
- May form large rounded “pillow” shapes on outcrop

Formation of Pillow Basalt

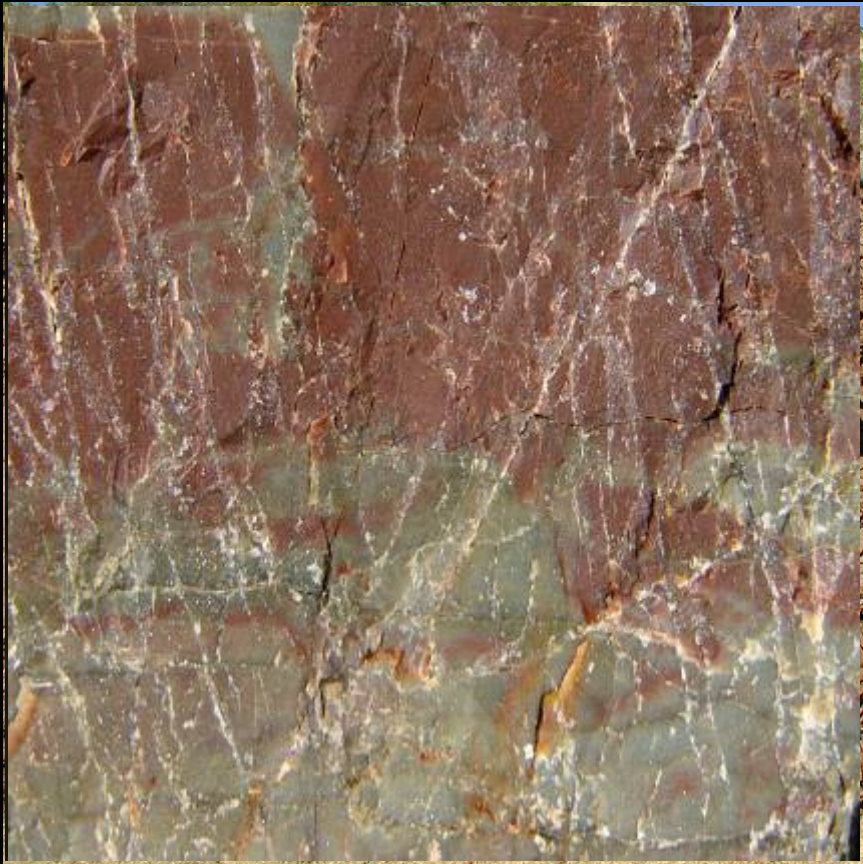






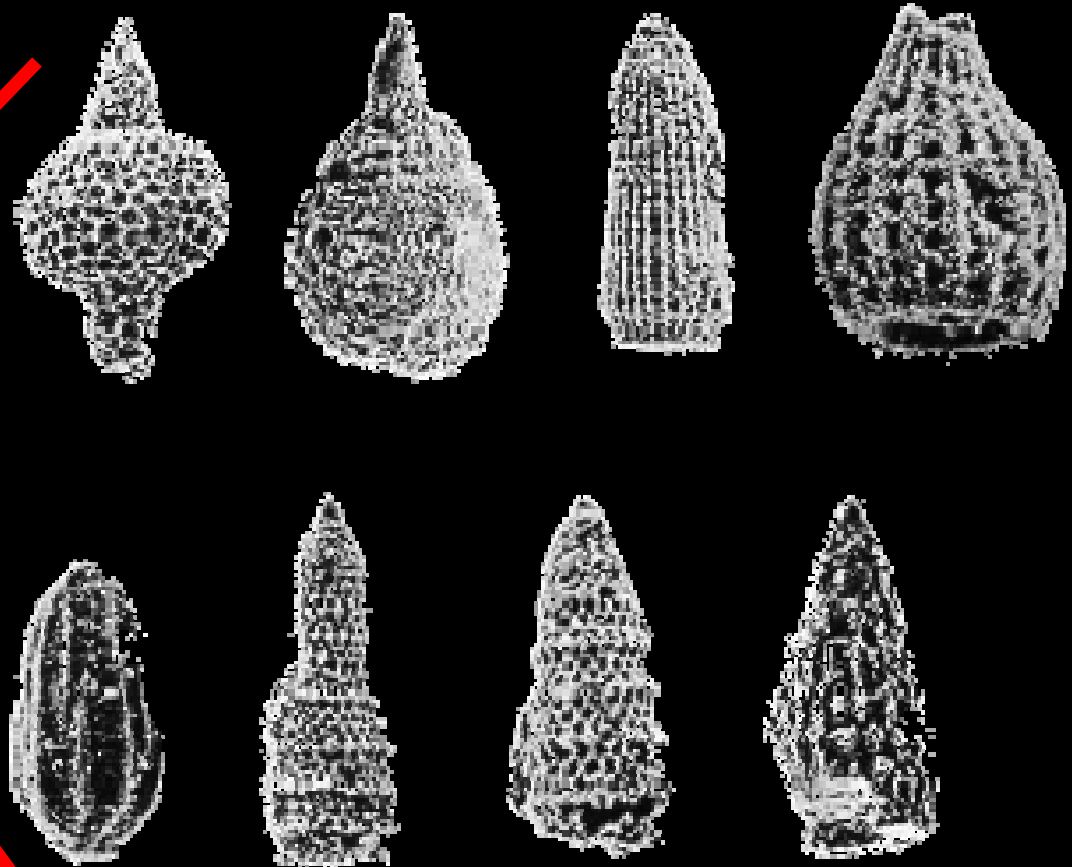
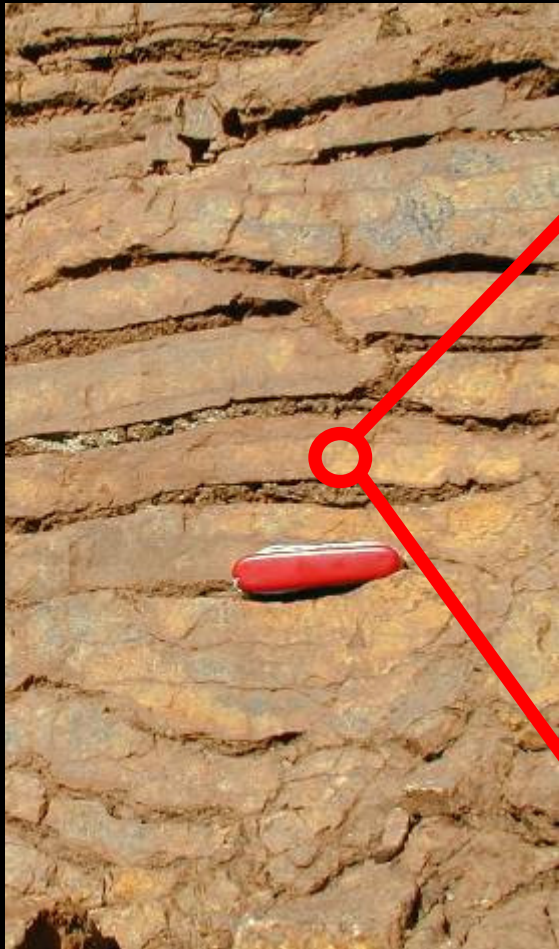


Chert

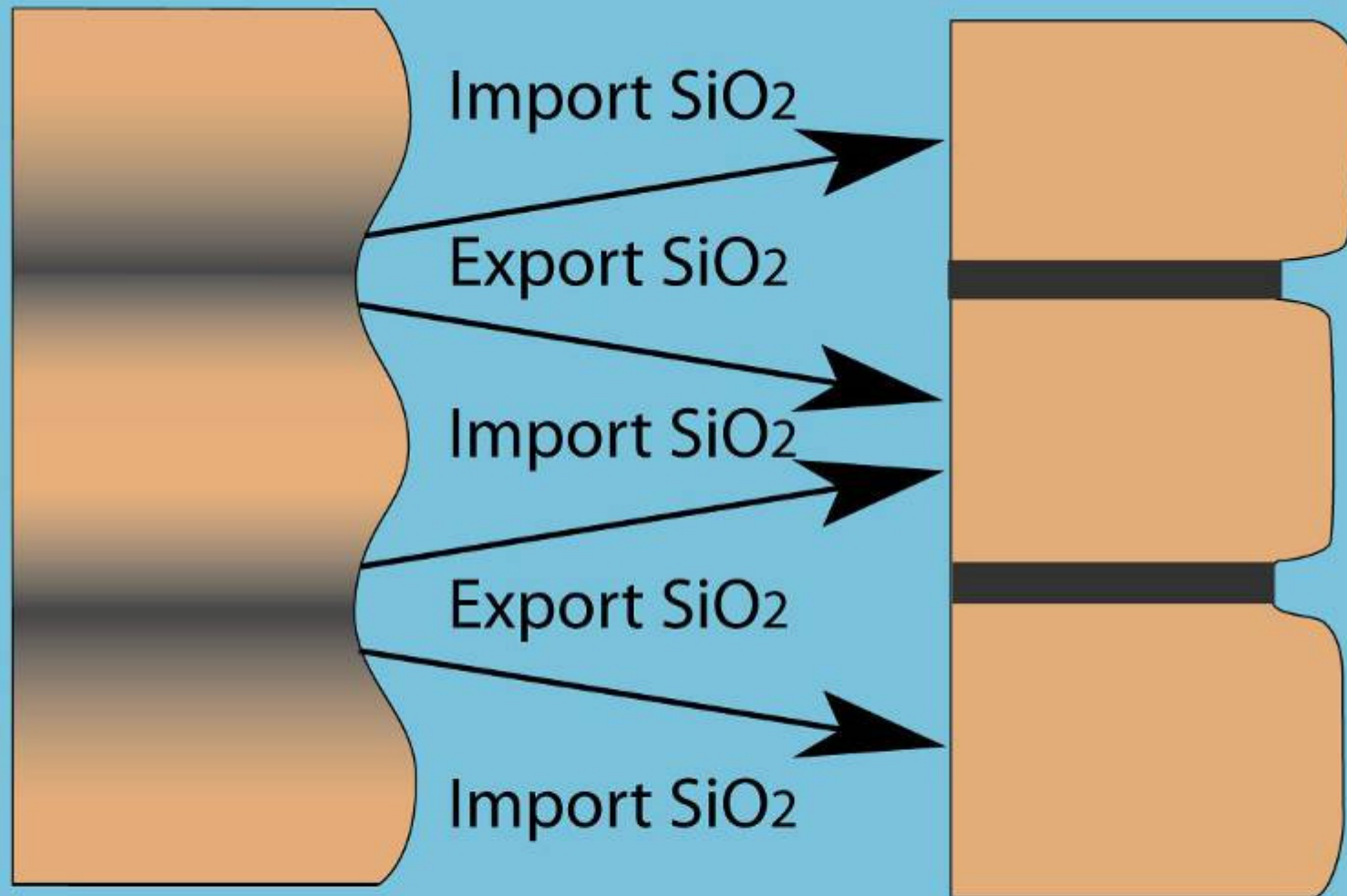


- Typically red, but may be green, yellow, pink or white
- No visible crystalline matrix or grains
- Glassy appearance and fracture
- Small clear spheres (Radiolaria) may be visible
- Forms ribbon-like beds on outcrop

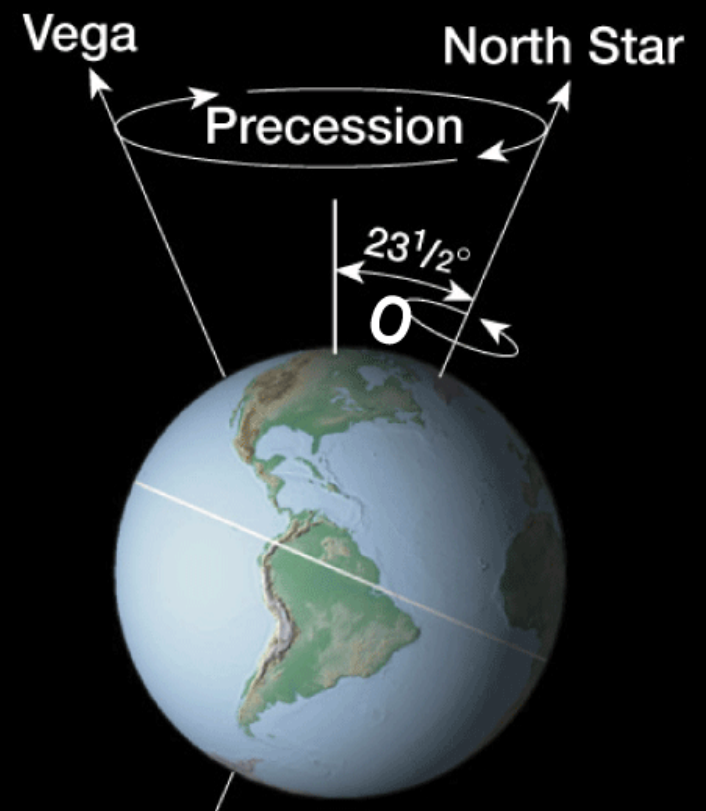
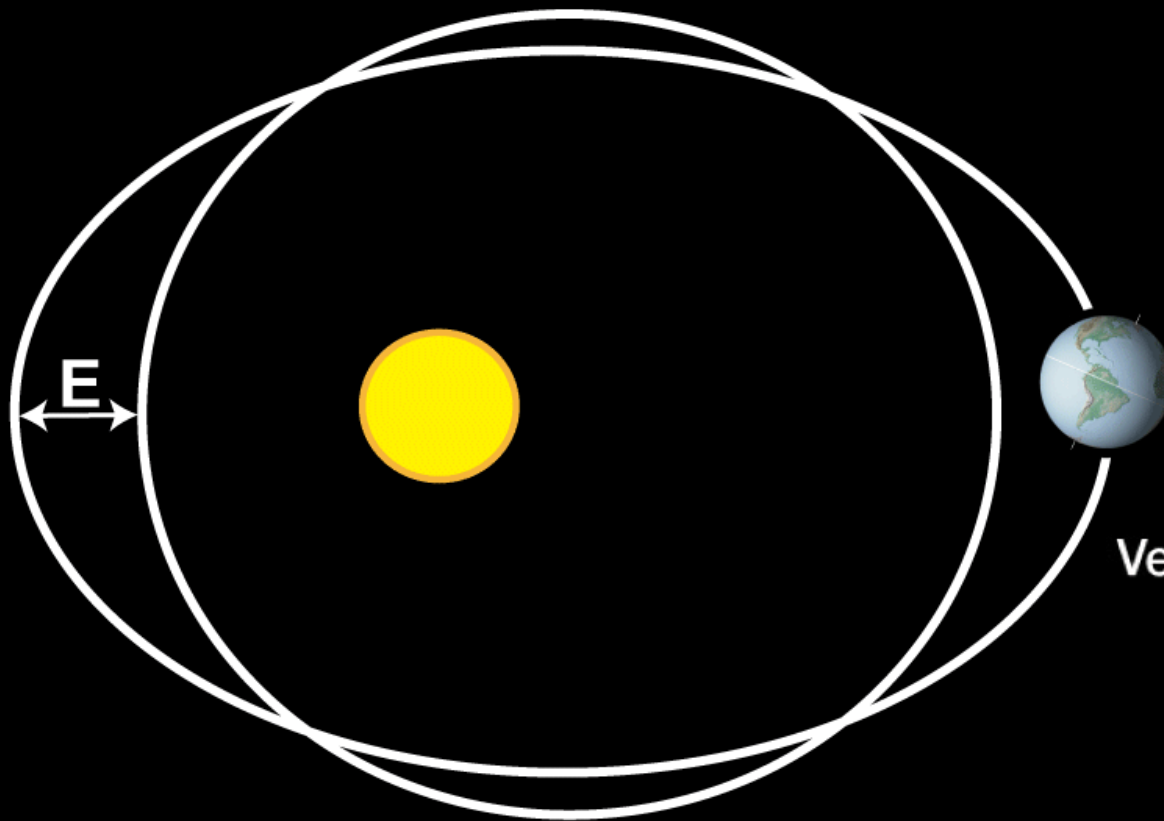
Chert & Radiolaria



200 – 100 Million Years Old



Diagenetic Enhancement of Chert Beds



Orbital Cycles

Eccentricity = 100,000 yrs

Obliquity = 42,000 yrs

Precession = 21,000 yrs



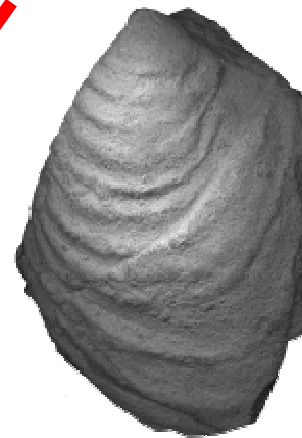
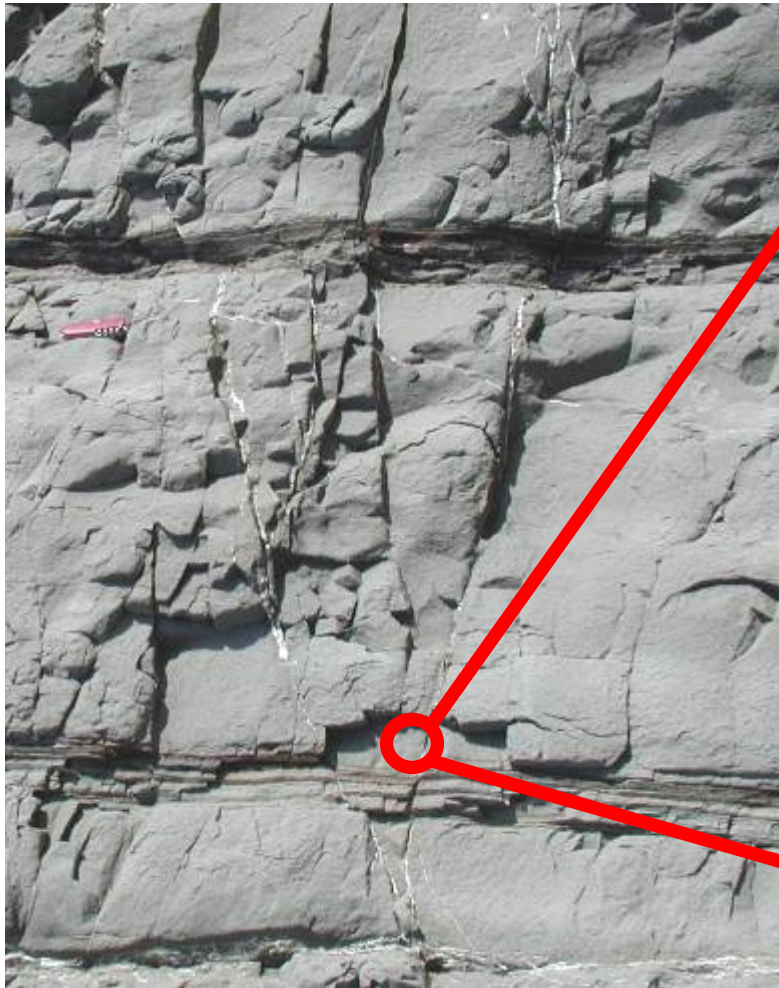


Graywacke Sandstone

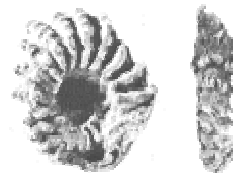


- Greenish gray
- Visible sand-size grains and sometimes pebbles
- Few clear quartz grains and many tiny volcanic rock fragments
- Typically forms thick sandy beds with thinner dark shale interbeds on outcrop

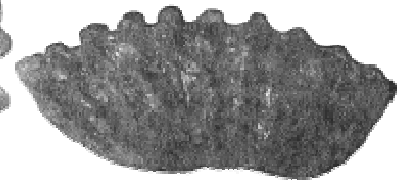
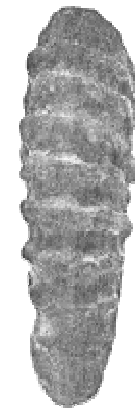
Graywacke & Mollusks



Inoceramus ellioti

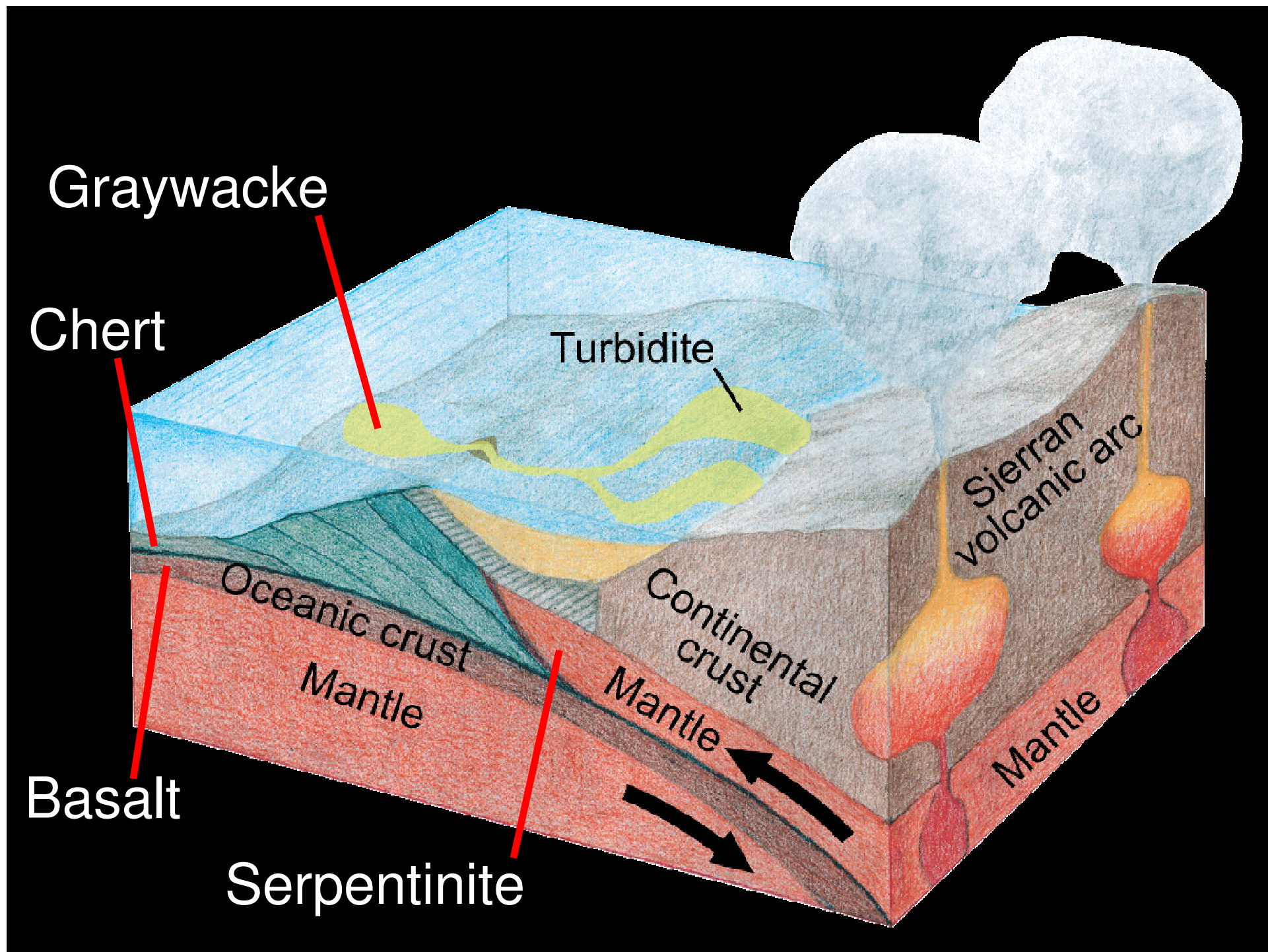


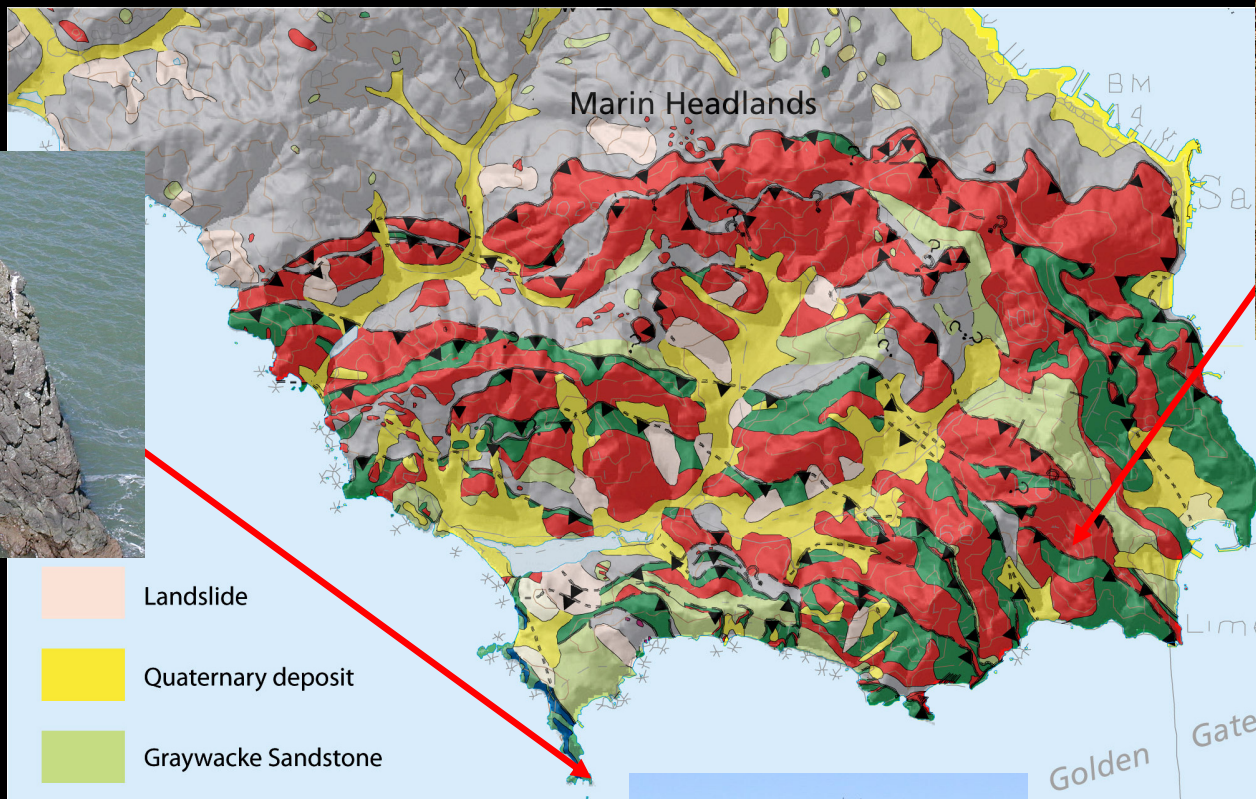
*Douvilleiceras
mammillatum*



Mantelliceras

130 – 100 Million Years Old

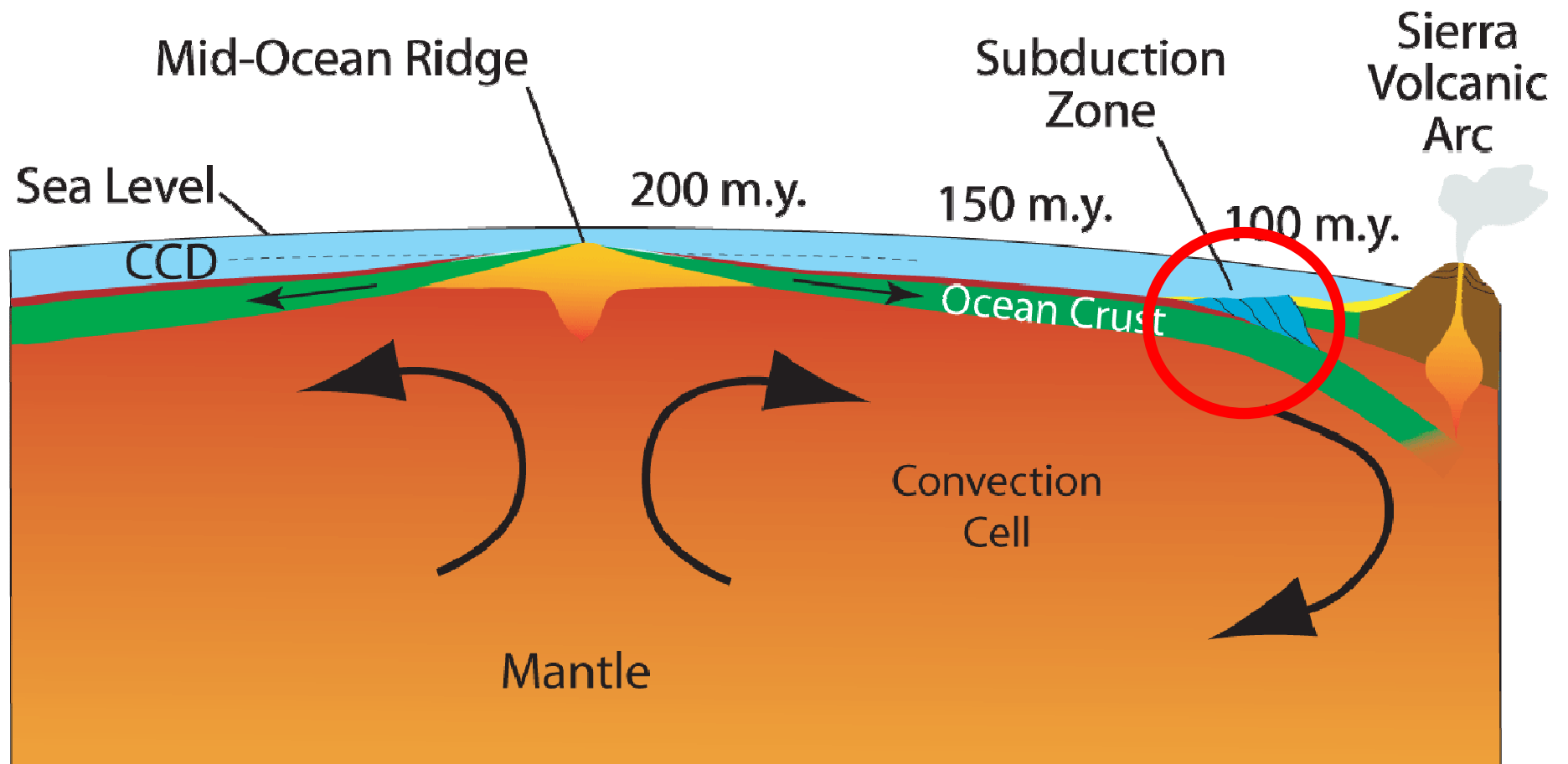




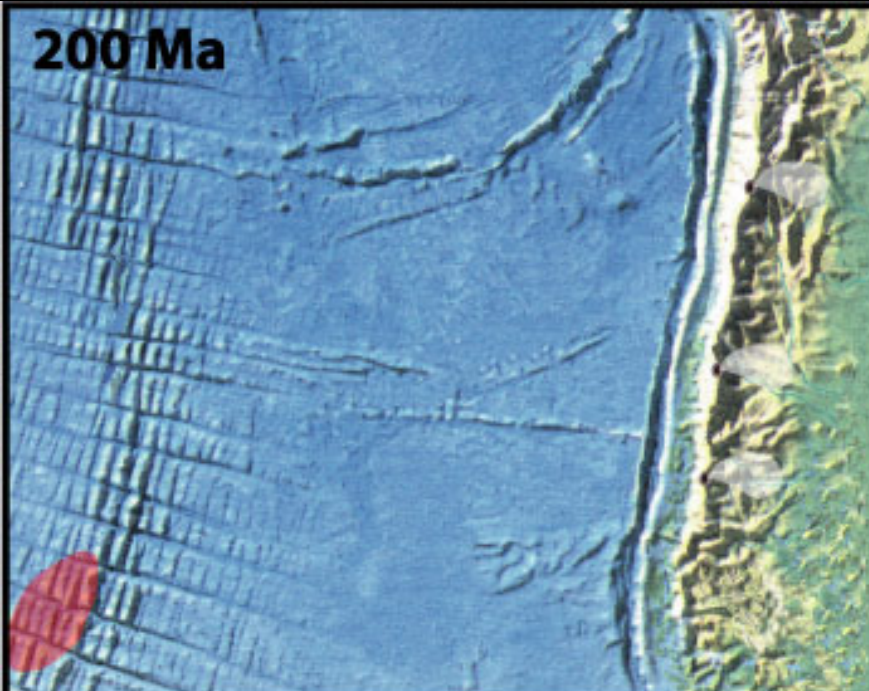
- Landslide
- Quaternary deposit
- Graywacke Sandstone
- Chert
- Basalt
- Diabase
- Serpentinite
- Melange



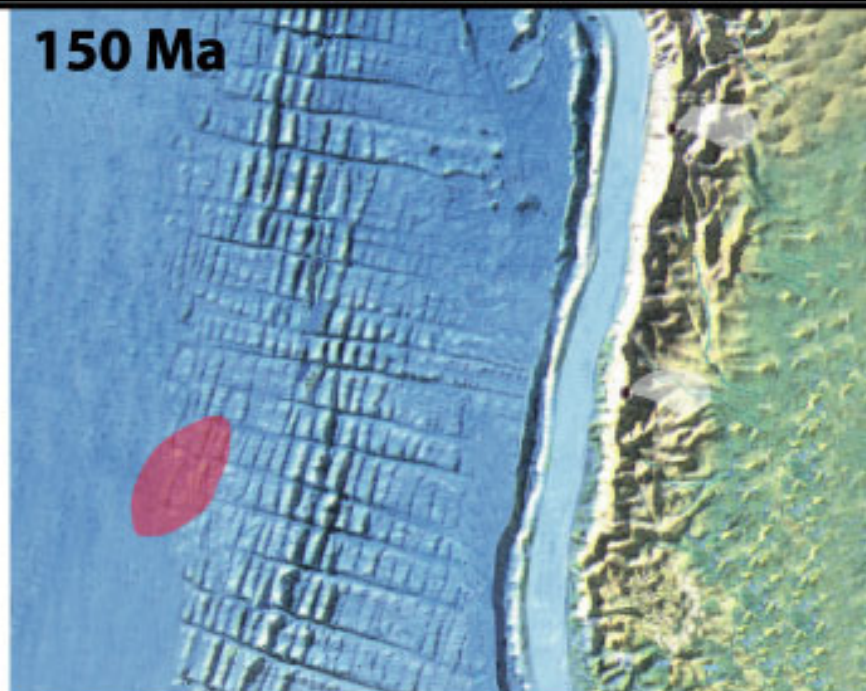
Plate Tectonics and Franciscan Rocks



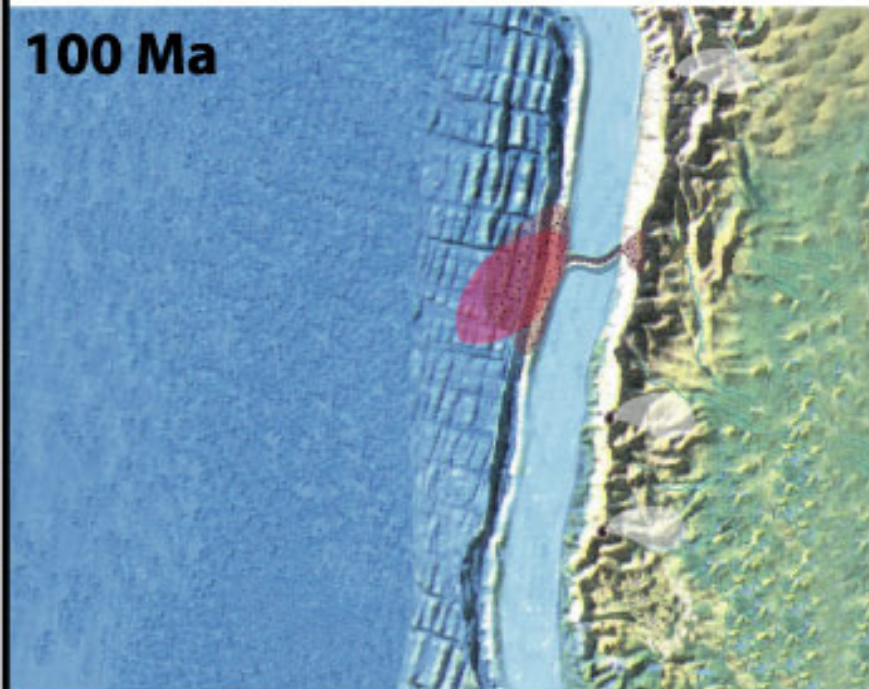
200 Ma



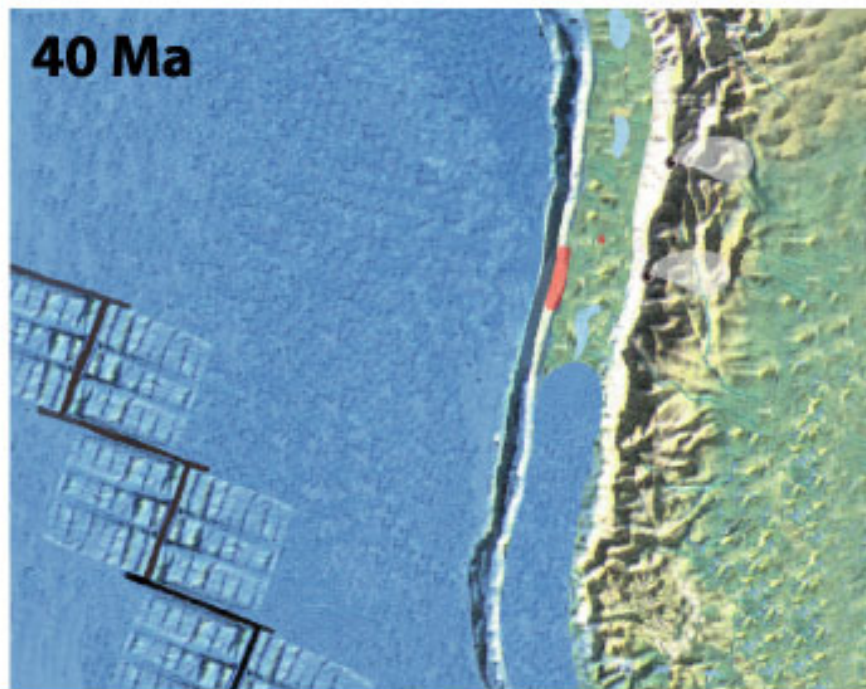
150 Ma



100 Ma

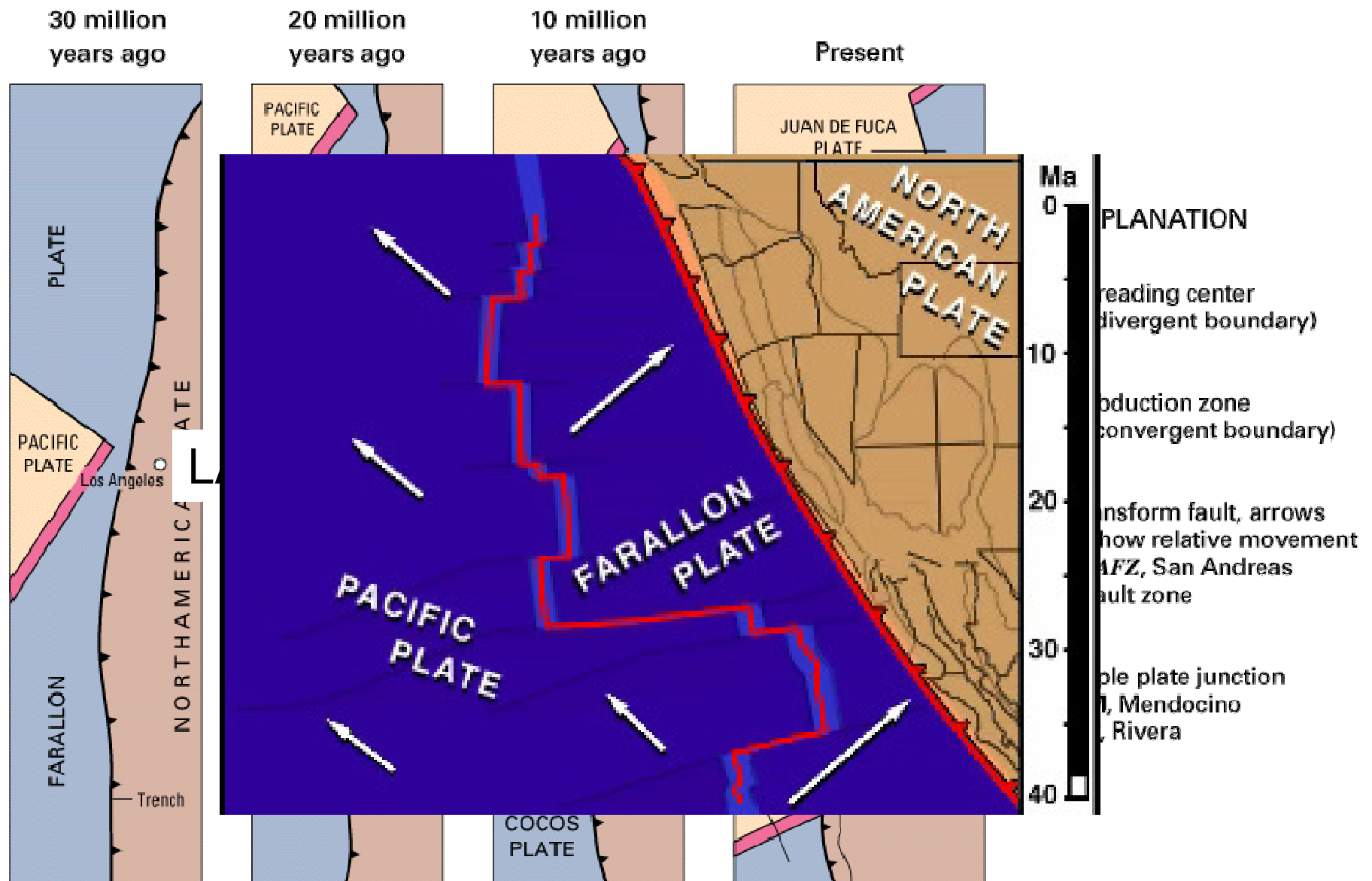


40 Ma









Franciscan Terranes

- San Bruno Mountain
- Novato Quarry
- Marin Headlands
- Alcatraz
- Nicasio Reservoir
- Yola Bolly
- Permanente
- Central

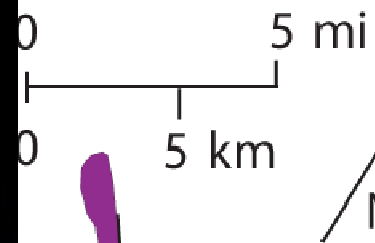
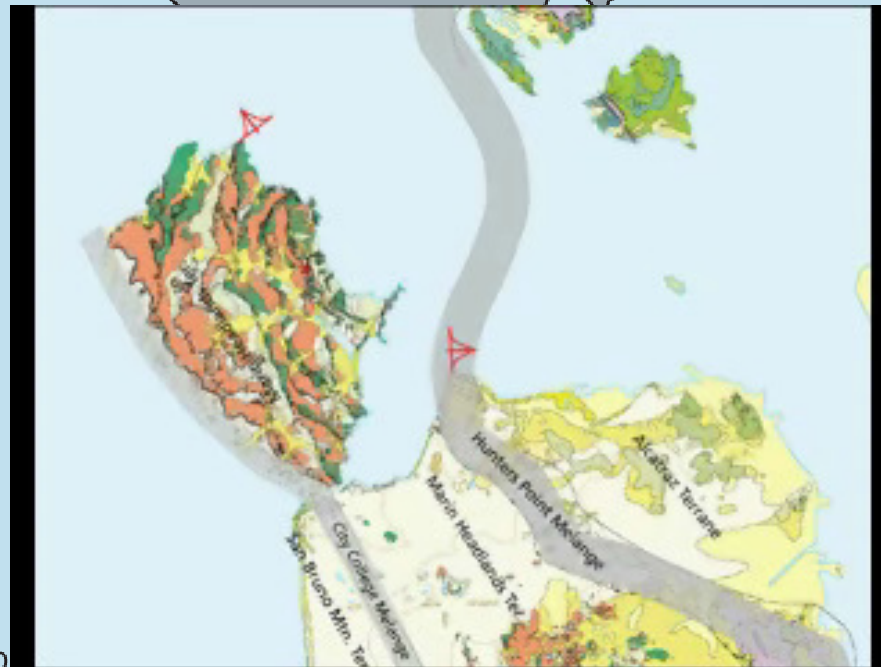
 Major thrust zone

Pacific Ocean

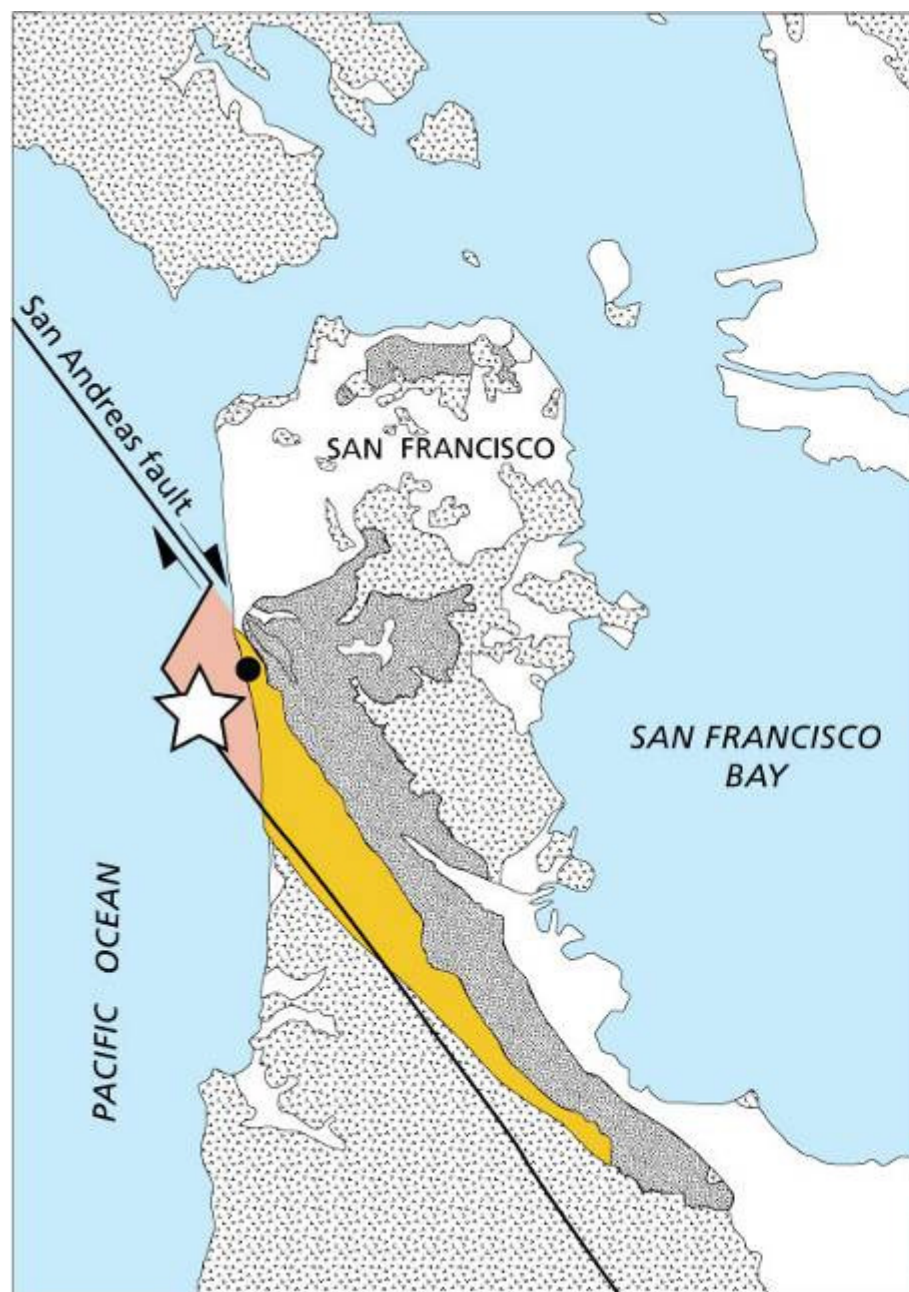
San Francisco Bay





San Pablo Bay

Hayward Fault







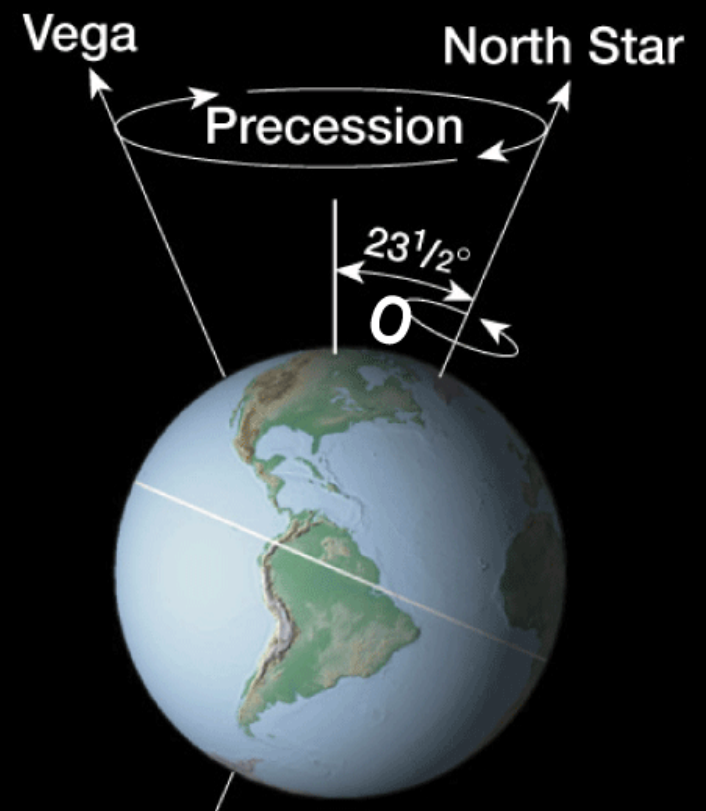
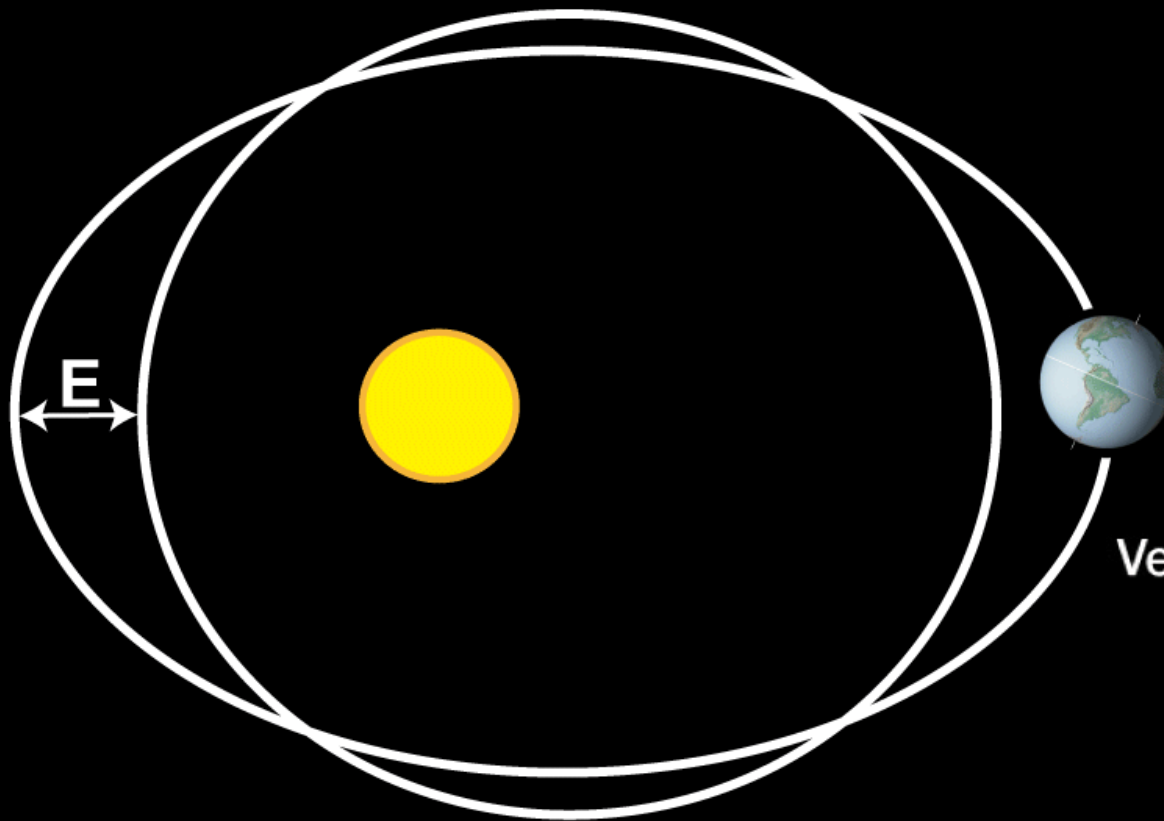


-  Younger than Colma
-  Colma Formation
-  Merced Formation
-  Older than Merced

0 5 MILES
0 5 KM

-  1906 earthquake epicenter
-  Fort Funston access





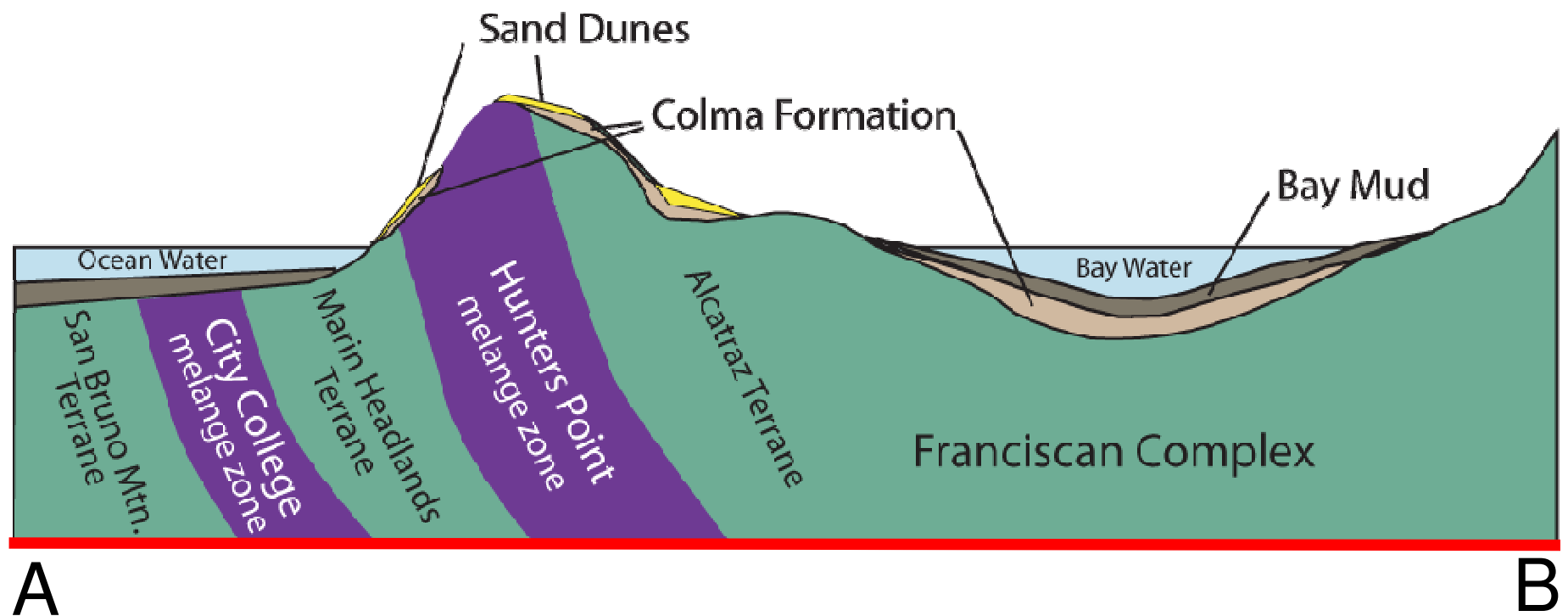
Orbital Cycles

Eccentricity = 100,000 yrs

Obliquity = 42,000 yrs

Precession = 21,000 yrs

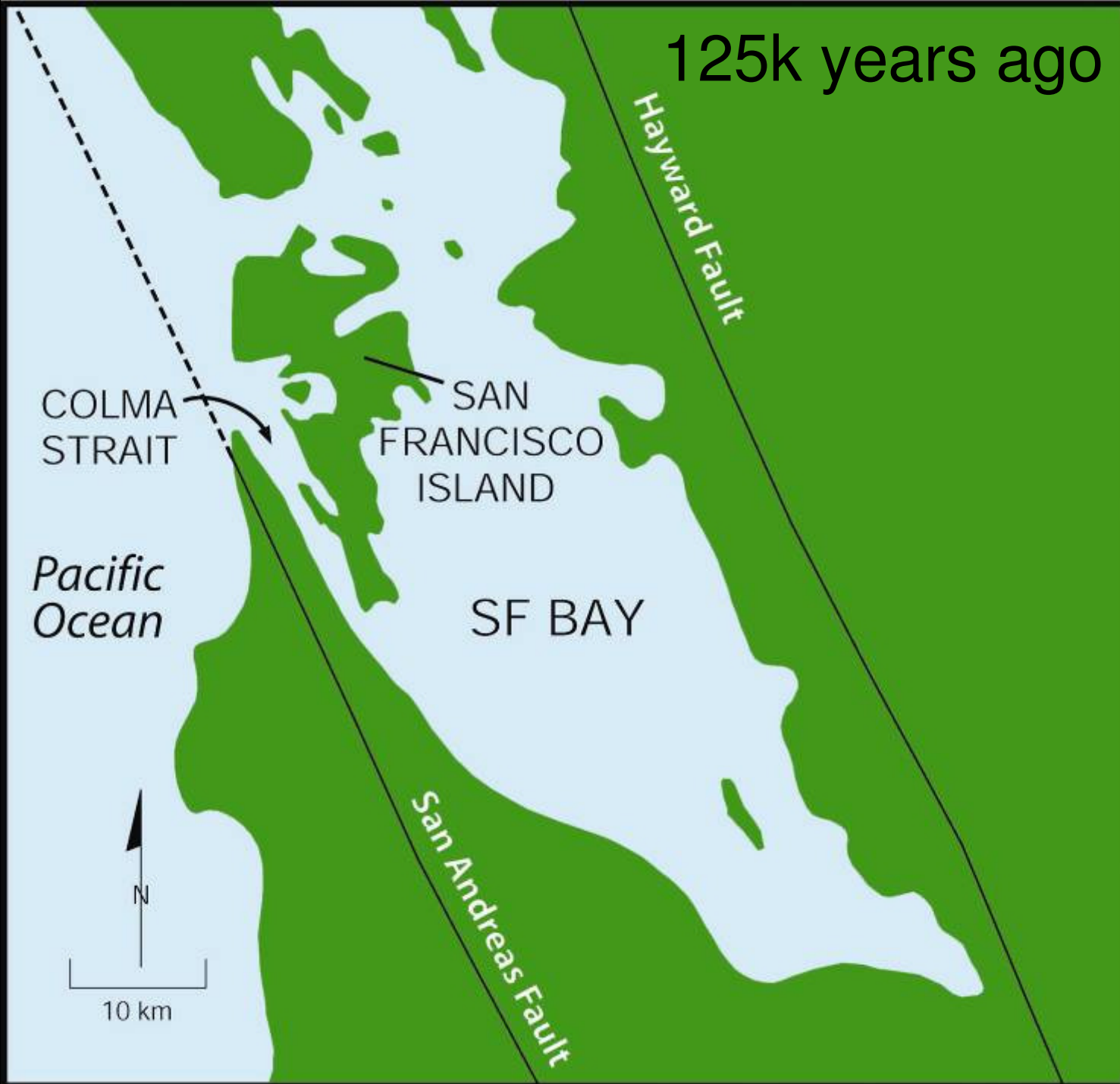
Geologic Cross Section



Colma Formation, Baker Beach

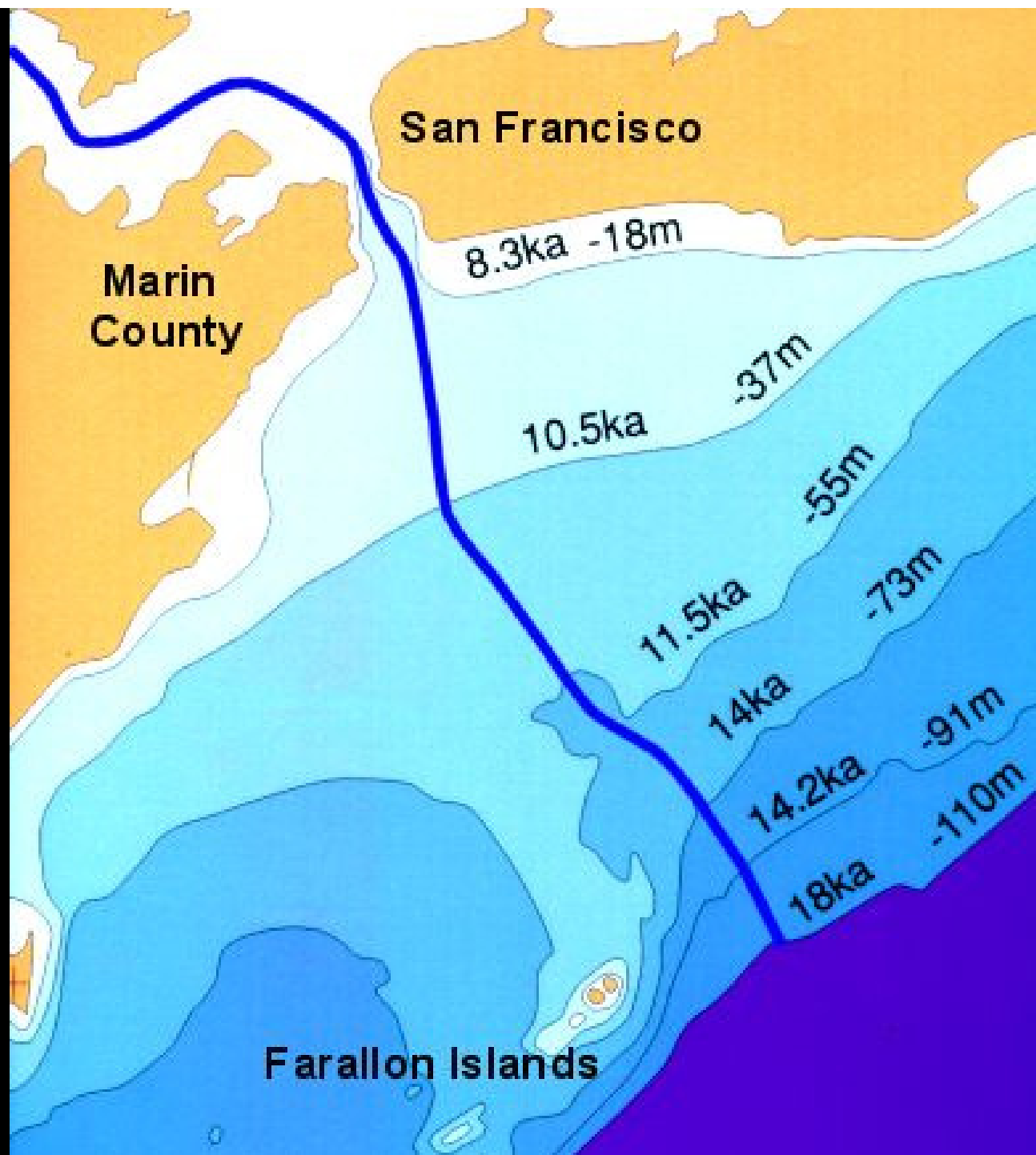


125k years ago





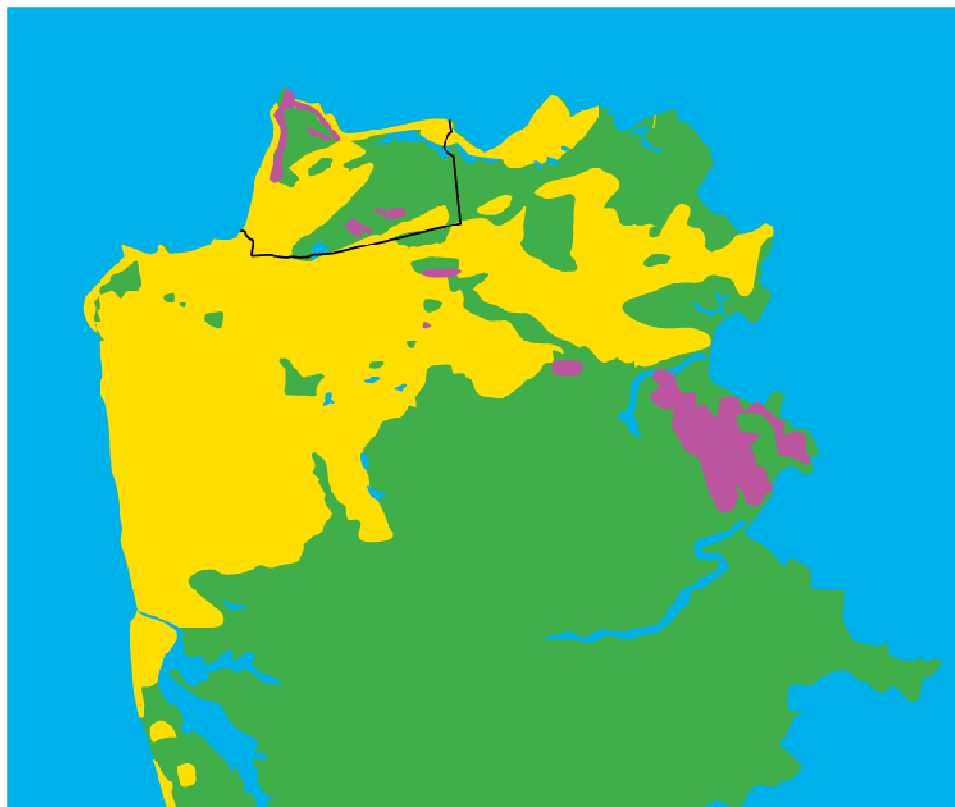




Recent Dune, Baker Beach



1800



2000



Sand Dune



Serpentinite



Other



National Park Service

Golden Gate National Recreation Area



San Francisco Rocks!

